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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

BREEDING – NEW TECHNIQUES AND APPLICATIONS

THE NEW APPROACH OF PRIMARY FOOD PRODUCTION AND DISTRIBUTION

FOOD 2030: NUTRITION, CLIMATE

Since the domestication of animals and plants in the Neolithic era, the human race has put efforts to breed new varieties of animals and plants. This can be achieved by traditional selective breeding or by new genome techniques such as genetic modification, or by modern New Breeding Techniques, which allow a faster breeding process.

SPECIFIC R&I BREAKTHROUGH TOPICS

New varieties of animals and plants: Traditional selective breeding is the process by which humans select specific parent animal or plant individuals to improve particular beneficial characteristics (phenotypes). By improving generations of those specific traits, humanity has achieved the existing species of today. This is a never-ending process, which provides new spec.

New genetic methodologies and new applications: The artificial engineering of the genome of organisms, traditionally known as Genetically Modified Organisms (GMOs), allows the creation of new species by introducing external genome sequences into known species, replacing, or cutting out sequences, thus leading to positive specific characteristics. Modern New Breeding Techniques (some known as CRISPR-Cas Technology) are not leading to what is considered as GMOs and allow to introduce genetic material already existing in the same plant species, allowing a faster selective breeding as it would be considered traditionally.

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EXPECTED IMPACT

Breeding techniques of animals and plants allow to have species with new characteristics which are beneficial for humans. In the case of plants, plants with increased drought resistance, "less water" resistance, higher resilient varieties, pest resistant or less fertilisers' dependency plants can be bred faster and more efficient. Some further examples are varieties with increased photosynthesis or plant seeds or leaves with a modified coating to provide higher resistance to dryer climates. In the case of animals, faster production rates can be obtained in certain species. Overall, it allows to tackle great challenges such as Climate Change and food and nutrition security, or less use of pesticides in plants and antibiotics in animals.

MARKET OPPORTUNITIES / CHALLENGES

- Investments and technology are ready for multiple applications.
- Traditional selective breeding is very time consuming, new genetic methodologies allow for faster and a more reliable process.
- The efficiency and resilience of new plant and animal breeds have to compensate for the possible costs of development and market insertion.
- There is controversy at the scientific community related to the environmental impact of new breeding techniques, mainly regarding the area of biodiversity and insects displacement.
- Legislation and consumer acceptance might be a barrier for many of the GMO and NPBT applications, affecting labelling issues and detection methods.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Climate change.
- Malnutrition.
- Scarcity of natural resources.
- Agricultural pollution.
- Engaged consumer
- Back to natural
- Novel foods
- Biodiversity loss.
- Transboundary pests and diseases.
- Genome engineering.
- Bio-fortification.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Goodberry
- HealthyMinorCereals
- Fishboost
- EggXYt
- Calxyt

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SMART FARMING

THE NEW APPROACH OF PRIMARY FOOD PRODUCTION AND DISTRIBUTION

FOOD 2030: CLIMATE, CIRCULARITY

Modern technology allows the possibility to increase the quantity and quality of animal and plant production. Smart farming includes a variety of digital tools based on data collection with the aim of producing more efficiently in combination with an improvement in environmental sustainability. Some of those tools are based in sensors, robots, advanced machinery, internet of things, data modelling or artificial intelligence.

SPECIFIC R&I BREAKTHROUGH TOPICS

Precision farming: The management of animal and plant production using near real-time observations and measurements applying digital tools is considered precision farming. Examples of these tools includes sensors to follow soil data, irrigation, foliar growth, weed development or pest management. Overall, these technologies can improve yield output, animal performance, food safety, and reduce farm inputs as fertilizers or pesticides, bringing higher profitability and sustainability to farms.

Use of global data: The data obtained through precision farming can be made globally available through web platforms and forecasts. This data can come from local sensors at farm level, from mobile Apps, from drone services or from satellite data. The data can be aimed to provide information at local level, thus giving smart access to farmers to critical information on farming.

Applied mechatronics: The use of robots and advance mechanical tools belongs to the field of mechatronics. Examples are advanced drones for data acquisition, autonomous tractors which use self-drive technology or specific autonomous robots for specific jobs such as picking fruits or removing weeds.

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Artificial intelligence applied to agriculture: The intelligence brought to machines is called artificial intelligence. Artificial intelligence allows machines to make decisions based on the acquired data, representing the highest level of crop and animal management in smart farming.

EXPECTED IMPACT

Smart farming has the capacity of providing higher quantity and quality, ensured food safety, better traceability, improved productivity, higher efficiency, less fraud, lower costs, improved use of chemicals and more benefits to a new era of higher sustainability of the agricultural ecosystem.

MARKET OPPORTUNITIES / CHALLENGES

- There is already a good availability of many of these technologies in the market, some of them showing good technical results: Allowing higher efficiency and lower environmental footprint of the farm activity.
- These technologies could bring a new motivation to attract an especilised workforce, helping to interest a young generation to the agriculture.
- Changes in the farmlands requires risk management. To achieve success, further support is needed to boost the economic and knowledge transfer factors.
- Often, these technologies are expensive for farmers. Loan and grant mobilization, public and private funding, cooperative renting, and other economic resources are still a challenge.
- The acquisition of skills for the use of many of these technologies requires the set-up of knowledge transfer, learning tools for adults, vocational skills training, or living labs to make them accessible for all.
- Smart Farming requires interconnection and exchange of data with all benefits and risks involved.
- There is a required infrastructure to support such as satellites, data exchange platforms, GPS technologies, etc.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Climate change.
- Malnutrition.
- Demographic change.
- Scarcity of natural resources.
- Engaged consumer
- New and Game-Changing Digital Technologies in Agriculture.
- Changes in farm structures.
- Agricultural pollution.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Novifarm
- eFooChain
- CtrlAQUA
- Fhytl Signs
- Flourish
- Prohealth
- Rootwave
- Ida by Connecterra
- AutomonPH by Waterice
- Iron Ox

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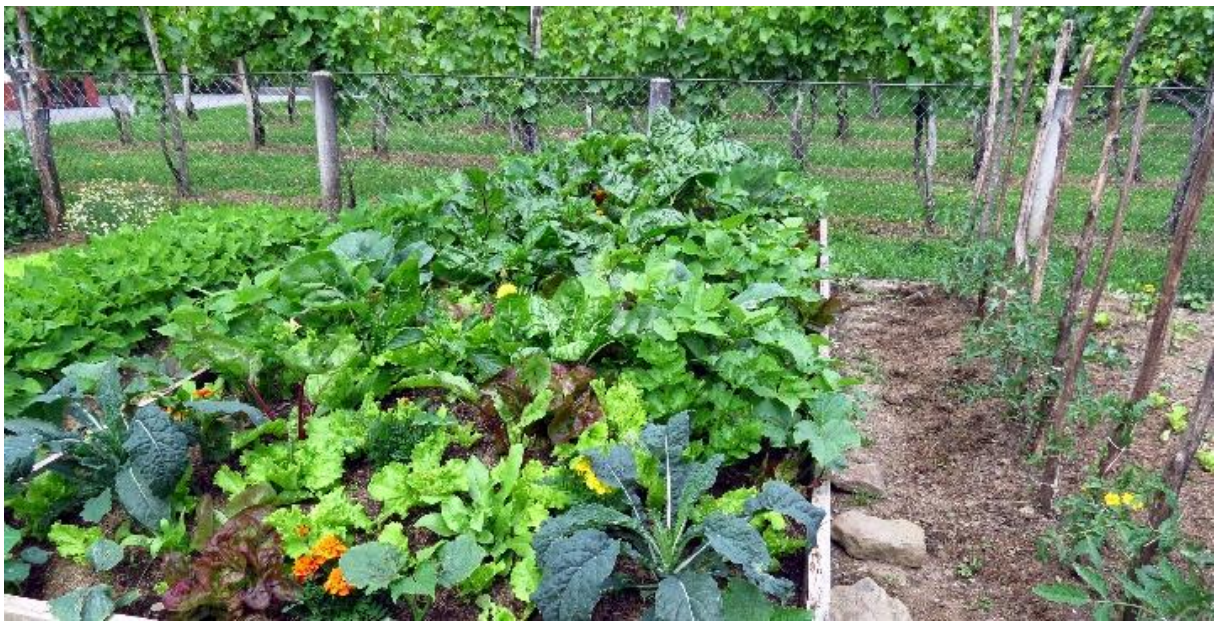
NON-CONVENTIONAL PRODUCTION SYSTEMS

THE NEW APPROACH OF PRIMARY FOOD PRODUCTION AND DISTRIBUTION

FOOD 2030: NUTRITION, CLIMATE, CIRCULARITY



After the third agricultural revolution in the 20th century, the mass production of agricultural goods has promoted the term of conventional farming. Non-conventional farming refers to methodologies which uses different approaches, from hydroponics, vertical agriculture, or urban farming, to agroecology, permaculture, or organic production, among others.

SPECIFIC R&I BREAKTHROUGH TOPICS

Hydroponics: It is the art of growing plants without the use of soil, using a water solution with the exact amount of nutrients needed. This technology allows the growth of plants without depending on soil and weather conditions.

Vertical agriculture: Also called vertical farming because it uses stacks of surfaces where plants are nurtured in a controlled environment.

Intelligent cropping: It includes techniques that include smart management of agricultural concepts such as smart crop rotation, reduced tillage, predator pest control or nutrient optimisation of soil.

Agroecology: By definition, agroecology applies ecological principles of environmentally sustainable agriculture. It incorporates a scientific approach as well as a social movement into crop management.

Permaculture: It emphasises on the ecological aspects of agriculture, also a social movement and a code of practice, many associate it with agroecology, although there are slight differences on design and implementation.

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Organic awareness: The organic production is characterized by the use of fertilisers of organic origin, which usually merges with techniques of crop rotation and biological pest control. Very often agroecology and organic production are inter-related, although the legislation in Europe is very clear for the definition and considerations of organic production all along the value chain, including processing.

Urban farming: By definition urban agriculture is considered within or near-by large urban populations. It includes many different perceptions where hydroponics and vertical farming are also included, but generally speaking it is perceived as an urban community movement that promotes the value of cropping in urban areas.

EXPECTED IMPACT

Although these new techniques have different methodologies and ideologies, overall they try to bring more environmentally and socially sustainable approaches, higher quality of crops, better use of resources and land, less intensive use of chemicals, and use of waste streams, for a higher sustainability of the agricultural ecosystem.

MARKET OPPORTUNITIES / CHALLENGES

- There is a social and ideological aspect to most of these agricultural practices, the market of the obtained products addresses not only economic aspects but also social and environmental issues.
- The associated costs and efficiency of these practices is generally higher than the market standards. However, there are more consumers in Europe willing to pay the extra costs.
- The legislation that applies to the production and labelling of the products obtained through these practices can be challenging for the new farmers that want to enter the business (e.g. organic production)
- There is the opportunity of developing circular business models in well-defined territorial contexts.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Climate change.
- Malnutrition.
- Demographic change.
- Scarcity of natural resources.
- New and Game-Changing Digital Technologies in Agriculture.
- Enganed consumer
- Health and food consciousness
- Changes in farm structures.
- Agricultural pollution.
- Organic farming.
- Indoor cultivation systems.
- Urban agriculture / Urban farming.
- Permaculture.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Kipster
- High tech Green House 2020
- Losaeter
- Ballymaloe Cookery School
- Foodmeters
- GrowUp Urban farms
- Herbert
- Micro gardens Dakar
- Soilfood
- Lufa farms
- Infarm
- Bioward Planty Organics
- Nemo's garden
- Seedforward: Freya
- Smart floating farms
- Agrophotovoltaics from Fraunhofer
- Farmers Cut
- Rootwave
- Viro Vet
- Bee flow

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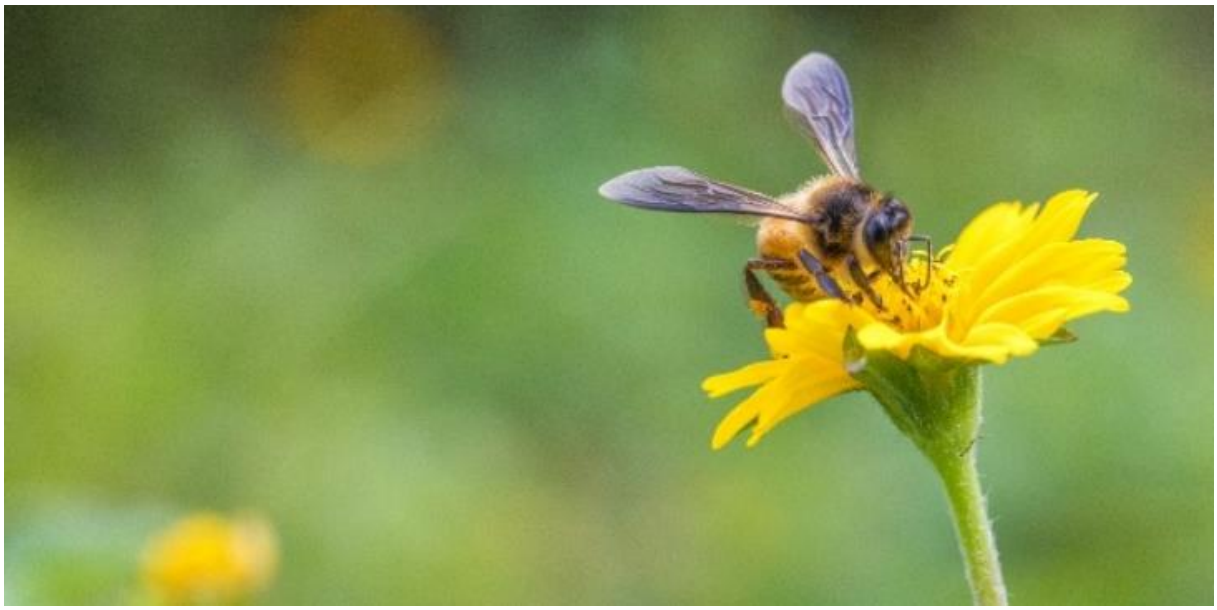
REDUCTION OF IMPACT PRODUCTION ENHANCERS

THE NEW APPROACH OF PRIMARY FOOD PRODUCTION AND DISTRIBUTION

FOOD 2030: CLIMATE, INNOVATION



The current agricultural production with its use of fertilizers and pesticides in plant production and antibiotics in animal production has brought challenges through their environmental impact. New approaches are searched to reduce that impact and improve the footprint of production.

SPECIFIC R&I BREAKTHROUGH TOPICS

New approaches to fertilizers: The nutrients of the soil are usually replenished using non-organic fertilizers. The market for the use of bio-fertilisers is extending, but also in the use of soil microbiome, fungi, nematodes, protozoa, and other beneficial organisms to convert unavailable plant nutrients to an available form for plant uptake.

New approaches to pesticides: The efficiency of crop yield is greatly diminished by the effect of parasites, insects, weeds, and other natural organisms. Chemical pesticides are commonly used, but many are considered hazardous for the environment or humans if used in large quantities. New solutions lead to pesticides that have lesser effects against the environment, the biodiversity and human health.

New approaches to animal antibiotics: Livestock farmers use antibiotics to keep animals safe from bacterial infections. However, the excessive use of antibiotics can create antibiotic-resistant bacteria which could be worst for animals and humans. Novel research approaches seek alternatives and new ways to reduce antibiotic use while maintaining animal health.

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EXPECTED IMPACT

Overall, this approach intends to reduce the environmental impact of agricultural production by using smart alternatives to the current production model with intensive use of chemicals. The expected impact should be a better footprint of production, better use of natural resources, and less environmental damage in the rural areas.

MARKET OPPORTUNITIES / CHALLENGES

- There is a new increasing market of products produced under these practices. Consumers start increasingly willing to pay more if there are indications of less environmental footprint.
- The solutions provided have to proof equal or near equal efficiency as the standard solutions to be viable, this is a challenge as usually there are trade-offs in the different provided solutions.
- The process of approval of many of these "new" solutions might take time, which makes the launch of products to the market difficult for new innovators and entrepreneurs.
- The use of smart technologies can be also used to minimise the inputs of production enhancers.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Climate change.
- Malnutrition.
- Scarcity of natural resources.
- Agricultural pollution.
- Biodiversity loss.
- Engaged consumer.
- Transboundary pests and diseases.
- Alternatives to conventional pesticides.
- Changes in farm structures.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Soilfood
- Lufa farms
- Infarm

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NEW VALUE SYSTEMS

THE NEW APPROACH OF PRIMARY FOOD PRODUCTION AND DISTRIBUTION

FOOD 2030: CLIMATE, CIRCULARITY, INNOVATION

Social, environmental, and economic sustainability is being gradually integrated in the agri-food value chain with the view to implementing sustainable business models that are able to address end users' concerns about the food purchased and consumed.

SPECIFIC R&I BREAKTHROUGH TOPICS

Business models for the primary sector are increasingly seeking to create positive value for a wider group of stakeholders, the environment and society, without compromising profits. Some examples are direct supply chains, ideation of added values using principles of ecology, or new consumer approaches through joint sales or joint distribution cooperatives.

Short food value chains are the chains where the food products are identified by and traceable to a farmer and for which the number of intermediaries between farmer and consumer are minimal. They can be *face-to-face*, when consumers buy a product directly from the producer/processor (e.g. on farm sales, farmer markets); *sales in proximity*, when products are produced and retailed in the region of production (e.g. food cooperatives, specialist retailers, food public procurement, catering, supermarkets); *sales at distance*, when products are produced outside of the region of purchase (e.g. PDO, PGI, internet sales, food box schemes).

Microcredit and microfinance allow people to obtain small loans at reasonable interest rates, receive remittances from relatives working abroad, safeguard their savings and set up small businesses. **Crowdfunding** aims to pool rather small amounts of capital from a large number of people resources, primarily through fundraising platforms, and has grown in importance as a financing tool.

Social innovation is the ensemble of practices that allow agri-food businesses to collect ideas from an external environment able to trigger innovation processes and increase their competitiveness, while meeting social needs. For example, the share of agri-food cooperatives in the EU is rising, as they increasingly offer employment

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opportunities and hold substantial market share in industries. Platforms for surplus food recovery and redistribution are spreading in EU countries as well.

EXPECTED IMPACT

New policies and management of the agricultural system can lead towards a new food revolution on the supply chain and use of resources for a more sustainable trade from the first producer to the final consumer. This will account for the margins gained on the process by middle-men and a more balanced equity on the costs of production. Such new business models have the capacity to re-socialise or re-spacialise food, thus allowing consumers to make value-judgments about foods. They affect food systems by generating greater employment opportunities, increasing retention of money within the local economy, increasing access to healthy, nutritious, and safe food, and encouraging farmers to adopt more ecologically sound production systems.

MARKET OPPORTUNITIES / CHALLENGES

- Crowdfunding and crowdsourcing provide opportunities for individual investors and consumers to become more directly involved in earlier stages of the food production cycle.
- Short value chains allow for a different consumer engagement where food has added values besides quality and price, such as environmental footprint, regionality or cultural heritage.
- Challenges arise in the current framework for food safety and quality regulations. Often the models followed by the new value systems have difficulties for this adaptation.
- The current distribution system where big retail supermarkets holds most of the market, puts pressure in the gross margins and the final prices that can be achieved. Waving away many potential consumers.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Trends aligned (with URL)
- Demographic change.
- Migration.
- Economic globalisation.
- Changes in farm structures.
- Responsible consumers.
- Concentration in Food Retail Markets.
- Short food supply chains.
- Chain clustering along the food supply chain.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Kipster
- Be-Farm
- Foodmeters
- Followfish
- Parkslope Food Coop
- Slowfood Europe

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NEW AQUACULTURE

THE NEW APPROACH OF PRIMARY FOOD PRODUCTION AND DISTRIBUTION

FOOD 2030: CLIMATE, CIRCULARITY

Aquaculture is one of the fastest growing food sectors, and innovative systems have been developed to increase its productivity of fish and crustaceans while reducing the environmental impacts by combining different methodologies. It is a booming sector where technological (breeding systems, vaccines, feeds) and non-technological (market standards, regulatory frameworks, organizational structures) innovation has raised, although still challenges remain for the full exploitation of its capacity.

SPECIFIC R&I BREAKTHROUGH TOPICS

Recirculating aquaculture systems (RAS): This type of advanced fish farms allows an enclosed inland system that recirculates water, reducing the quantity of clean water needed. The main challenge is the elimination of ammonia, that can be performed through biofiltration, although other solutions exist using "aquaponics" – using natural resources in the trophic chain such as algae.

New feeds: Aquaculture feed production requires fish meal and oil, and products from agriculture as ingredients, and utilises large amounts of land, water, and energy. New alternative feeds include meals and oils from plants (e.g. soybean, canola, barley, rice, peas, lupine), fish processing waste, yeast, animal by-products, insect proteins, and seaweed are being explored to substitute traditional ones.

Enclosed culture production: This type of systems called cage or pen cultures, enclose the fish, crustacean or mollusks in a wild environment under an enclosed perimeter. This innovation has been long implemented, but the resolution of its challenges can provide higher productivity and better environmental impact.

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Integrated multi-trophic aquaculture (IMTA): From the principle of including organisms from different trophic levels of an ecosystem (e.g. fish, shellfish, algae), so that the byproducts of one become the inputs of another. It tries to bring the principles of a circular economy into the blue footprint.

EXPECTED IMPACT

There is potential for a better exploitation of the seafood resources, from the feeding system to food safety and authenticity. Innovative aquaculture systems such as a closed one, RAS and IMTA increases the efficiency of the production cycle, utilizes waste water more efficiently and reduce the amount of required fish feed.

The development of new feeds that are commercially viable as substitutes for fish meal and oil will enable widespread alternative feeding practices that are successful in reducing dependence on marine fish resources, protecting biodiversity, maximizing efficiency, and minimizing waste.

MARKET OPPORTUNITIES / CHALLENGES

- The costs for the implementation of advanced aquaculture systems are often high and entail massive energy consumption as well as dependency on complex technology.
- Wastewater fishponds might play an important role in the future for the recycling of organic wastes.
- The use of insect proteins in aqua feed paves the way to new feed markets for insect producers, feed manufacturers and seafood farmers.
- There are technical and social challenges still to overcome that requires research: From the spread of diseases, the impact on environment or the productivity rates; to the consumer acceptance, lack of specialised workforce or heterogenicity in the current regulations in different countries.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Climate change.
- Scarcity of natural resources.
- Food from the sea.
- Closing the loop in aquaculture.
- Food waste recovery up-cycling / waste cooking.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- GrowUp Urban farms
- Agriprotein
- CtrlAQUA
- Climefish
- Nemo's garden
- Smart floating farm
- Fishboost
- Nature Scouts Association (TR)

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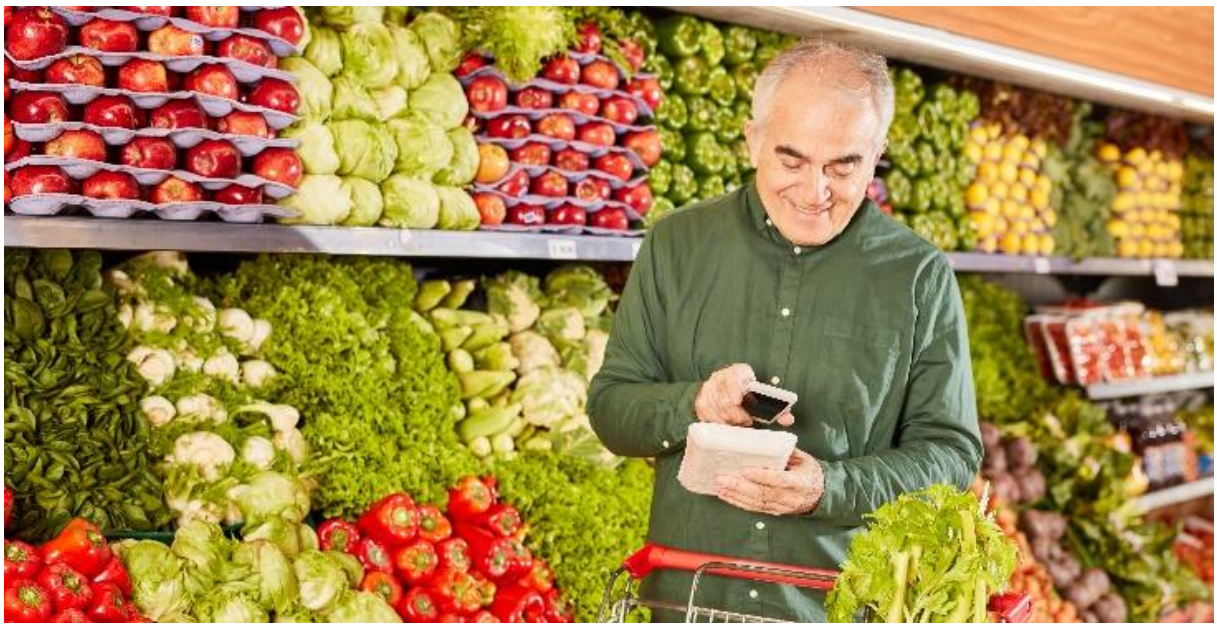
THE EMPOWERED CONSUMER

AN ENGAGED AND HEALTHY CONSUMER

FOOD 2030: NUTRITION, INNOVATION



Consumer engagement extends the role of consumers beyond passive purchasers of what supply chains provide, to active and self-organizing players who shape the food system and develop solutions based on their values and preferences.

SPECIFIC R&I BREAKTHROUGH TOPICS

Informed consumers and food labelling: The basis for all consumer engagement is information. Mere prices do not reveal information on supply chains, food processing, transport, ethical issues etc. concerning food. Food labelling (smart, standardized, integrated related to healthy, ethical, and socially fair food) can be a crucial vehicle, in order to document and render visible the social and environmental costs of consumers' daily food choices. Without coherent food labelling, it is impossible for consumers to decide if e.g. a tomato grown locally in a Western European country but in a glass house with heating and/or cooling is more environmentally friendly than one transported from a southern country farther away.

Active citizenship and education. Food-related education should on the one hand start at an early age to be able to impact on habits and act as a driver of healthy eating.; On the other hand, life-long education and engagement are equally crucial. Food contexts change over people's lifetimes, and novel scientific insights and debates must have a way to reach consumers in order to have an impact on their food choices. However, the form food-related education should take is under scrutiny. At the moment, food-related education is shaped by the senders/tutors, and information gets lost in the process of transmission because recipients' requirements and needs are not met. FIT4FOOD2030 experimented with developing training based on what recipient communities' own needs for the transformation of their local food system. Moreover, schools increasingly take an active role - as exemplified by the City Lab Athens hosted at the Ellinogermaniki Agogi which is pursuing a model of an open school where food project-based learning unites students, parents and the local community - and there are other spaces, agents and roles whose educational potential is still underexplored. Furthermore,

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there is a chasm between knowing and doing; a richer understanding of the factors being people's food choices can complement educational initiatives and help them facilitate more sustainable and healthier diets.

Co-creation and Living Labs: The concept of Living Lab refers both to an organization and a space where open and collaborative innovation can happen in a real-life context and through a process of co-creation that includes a diversity of actors. The experience of FIT4FOOD2030's Labs at the local and national level has shown that such intermediary structures can be, if designed with care, an appropriate tool for engaging final consumers, public authorities, industry and NGOs in value co-creation. Through living labs and other forms of participation, citizens can contribute to shape "their" food system jointly with system stakeholders.

EXPECTED IMPACT

From the perspective of a supply-driven food system, engaged consumers are just one form of input for R&I activities. However, from a societal perspective, empowerment plus engagement of consumers should contribute to a food system that is shaped according to the values and preferences of society. A [consumer]value-based food system focusses both on economic and non-economic long-term shared values, like equality and social fairness across the food system, environmental sustainability, clear standards, animal rights etc.

MARKET OPPORTUNITIES / CHALLENGES

- Market access of novel solutions plays an important role, as market access drives demand. If active consumption means that each and every consumer has to stand up and dedicate extra time in pursuing (at first) special food choices, active consumption will be left with a minority. The empowerment of consumers and market access to novel products often goes hand in hand with disempowerment of established other actors.
- Consumer choices are characterized by trade-offs and tensions between price and other aspects of food such as impact on health and sustainability.
- Transparency from farm to fork, but consumers should not bear all the responsibility of following, from farm to fork, all the information that is made available in a fully transparent system.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Big data analysis.
- Economic globalisation.
- Health and food consciousness.
- Responsible consumers.
- Destabilised consumer trust.
- Fast and convenient food.
- Changing households and food.
- Consumer engagement.
- Social media and food.
- New shopping behaviour.
- Physical internet.
- Responsible research and innovation.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Followfish
- Foodintegrity

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

- Mimica Touch
- Animals' rights
- Bee urban

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

CHANGE OF DIETARY HABITS

AN ENGAGED AND HEALTHY CONSUMER

FOOD 2030: NUTRITION

Poor quality diets are among the top six risk factors contributing to the global burden of disease, mainly through malnutrition and non-communicable diseases (NCDs). The latest is highly linked to poor diets: low in fruits and vegetables, high in sodium, low in whole grains, nuts, and seeds, and low in omega-3 fatty acids. Innovation in education, policy making, ingredient research and product development, and new insights in consumer behaviour are some of the leavers to drive this trend.

SPECIFIC R&I BREAKTHROUGH TOPICS

Awareness of healthy habits: Dietary habits have many factors which have a social and cultural background. The country we live in, the education we receive, the house economy, the job and lifestyle we have are just some of the factors that influence our food choices. Awareness is a first step, which requires the understanding of consumer behaviour, but also the methodologies in education, the understanding of the transmitted social values, or the existing trends in lifestyle. This requires knowledge and systems in place to deliver this knowledge, adapted to the factual communication channels of citizens.

Reduction of targeted ingredients: There are targeted ingredients that are known to be consumed excessively in unbalanced diets such as salt, sugar, and saturated fats. Others are lacking: high fibre foods, whole grains, nuts and seeds, and some vitamins. Efforts are made to reformulate recipes in such a way that the population can change the balance of those components keeping the taste and price of the usual consumed goods.

Reduction of targeted additives (clean label): There is an effort from the food industry to substitute and reduce certain additives and ingredients from recipes. This is named “clean label”, which means the elimination from the label of such components, very often identified with E-numbers in the European legislation. However, this is usually linked with higher transparency on the components (e.g. allergens) in the communication with consumers.

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No774088

EXPECTED IMPACT

The final goal is clear: a healthier population. This involves less non-communicable diseases, healthier growth, and healthier ageing. However, the way we can measure this impact, or the pathways to achieve it, is not clear and research is needed to aim with a higher accuracy the different efforts that are made worldwide.

MARKET OPPORTUNITIES / CHALLENGES

- There is a will from most of the countries to create awareness towards the issue of unhealthy diets, starting from the efforts of the United Nations, WHO and FAO.
- There are many cofounding factors in the research of dietary habits, which requires consumer behaviour and social behaviour knowledge to be able to understand the drivers behind negative dietary habits, often linked to lifestyle.
- Lack of awareness is often linked to strong trends such as urbanisation, globalisation or lose of culinary habits, which disconnect the society from the sources of food and the sustainability parameters within.
- The market opportunities gets diluted by the lack of homogeneous policies among countries which sets different standards and regulatory measures in the ingredients and products to target.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Rise of non-communicable diseases.
- Demographic changes.
- Biofortification.
- High/Ultra processed foods.
- Clean eating / transparent labels.
- Novel foods.
- Natural preservatives and milder processing methods.
- Alternative protein sources.
- Functional foods including pro&prebiotics.
- Health and food consciousness.
- Responsible consumers.
- Special diets like vegetarian, vegan or low carb.
- Destabilised consumer trust.
- Fast and convenient food.
- Low prices, high calories.
- "Free-from" products.
- Smart personalised foods.
- Globalisation of diets.
- Consumer engagement.
- Traditions and Do It Yourself.
- Social media and food.
- Food regulation.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Baltimore food policy
- KromKrommer
- Alexandra Rose Charity
- Habit
- Doux Matok
- Perfect day
- Geltor
- Sugarlogix
- Miraculex
- Beyond meats
- Clara foods
- New Wave foods

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

NEW TOOLS TO IMPROVE NUTRITION AND HEALTH

AN ENGAGED AND HEALTHY CONSUMER

FOOD 2030: NUTRITION

Innovative and high-performance technologies are revolutionising medical research due to their ability to assess individual health indicators, and thus allow the examination of multiple human and environmental conditions simultaneously. This is proving powerful in targeting and preventing human diseases more accurately.

SPECIFIC R&I BREAKTHROUGH TOPICS

Personalised nutrition: Personalised nutrition is based on the use of genetic, phenotypic, medical, nutritional, and other relevant information about individuals to deliver specific and targeted advice, products, or services, with the view to achieving a dietary behavioural change that is proved to be beneficial for health. Consumers are increasingly more proactively involved in the design and production of the food they purchase through co-creation and innovative technologies.

Multi-Omics: Starting from genomics, transcriptomics, proteomics, and metabolomics, a variety of omics subdisciplines (epigenomics, lipidomics, interactomics, metallomics, diseasomics, etc.) has emerged, offering the opportunity to understand the flow of information that underlies disease. Foodomics is a new, comprehensive, approach to food and nutrition that intend to correlate the intrinsic characteristics of foods (for example related to food composition, biochemical properties of active ingredients, food processing and technologies used in food production) with the impact on human health indicators.

Nutraceuticals: Nutraceuticals refer to dietary supplements, functional food, medicinal food, and pharmaceuticals, and have attracted considerable interest due to their potential nutritional, safety, and therapeutic effects in improving health, preventing chronic diseases, postponing the aging process, and generally supporting body functions and integrity.

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Functional foods: Functional foods exerts specific health benefits to the human body that extend those basically associated to their nutritional value, thus improving overall human health status, or reducing the risk of certain diseases. Functional products refer to several categories of foods: either conventional food naturally rich in nutrients like vitamins, minerals, antioxidants and heart-healthy fats; food fortified with additional nutrients (e.g. juices); food enriched with new ingredients (e.g. pre- and probiotics); or food altered by removing/reducing/replacing particular components.

Human genome knowledge and application: Gut, oral, respiratory, and skin microbiomes play an important role in specifically shaping the response of each single individual to diet and have the capacity to rapidly respond to environmental factors, such as diet, lifestyle, climate among, etc.

EXPECTED IMPACT

Further knowledge of human health and the tools available to measure and to influence nutrition and healthy eating habits. Indeed, personalisation may foster a sustained change in dietary and purchasing behaviour and is likely to drive scientific developments beneficial for public health. The application of multi-omics technologies through the adoption of a foodomics approach integrates multiple levels of research and models, and allows the optimisation of human health and filling in knowledge gaps.

MARKET OPPORTUNITIES / CHALLENGES

- The market for personalized nutrition is expanding, as it attracts both people suffering from a disease and healthy people willing to monitor their health parameters, caloric intake, daily steps, etc. As the widespread use of fitness watches and similar applications demonstrate.
- Market demand for new tools is driven by consumers' concern about health risks, as well as the perception that the pursuit of wellness and a good fitness condition is a top priority, especially for the emerging middle class.
- A foodomics approach to multi-omics technologies can help multi-background researchers and scientists in the area of food science and nutrition to have better access to data, thus resulting in improvements in food safety, new foods formulation, and animal nutrition, and a better understanding of the impacts of environmental exposure.
- Developing microbiome-based dietary interventions can be cost-effective measures to prevent diet-related and improve human lifestyle by modulating the individual eating behaviors.
- Translating human genome sequencing into medical therapies that will benefit individuals requires strategies to handle large amounts of biological and medical data.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Rise of non-communicable diseases.
- Demographic changes.
- Biofortification.
- High/Ultra processed foods.
- Clean eating / transparent labels.
- Novel foods.
- Functional foods including pro&prebiotics.
- Health and food consciousness.
- Responsible consumers.
- Special diets like vegetarian, vegan or low carb.
- Fast and convenient food.
- Smart personalised foods.
- Globalisation of diets.
- Consumer engagement.
- Traditions and Do It Yourself.
- Social media and food.
- Food regulation.

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ASSOCIATED CASES IN FIT4FOOD2030 (URL)

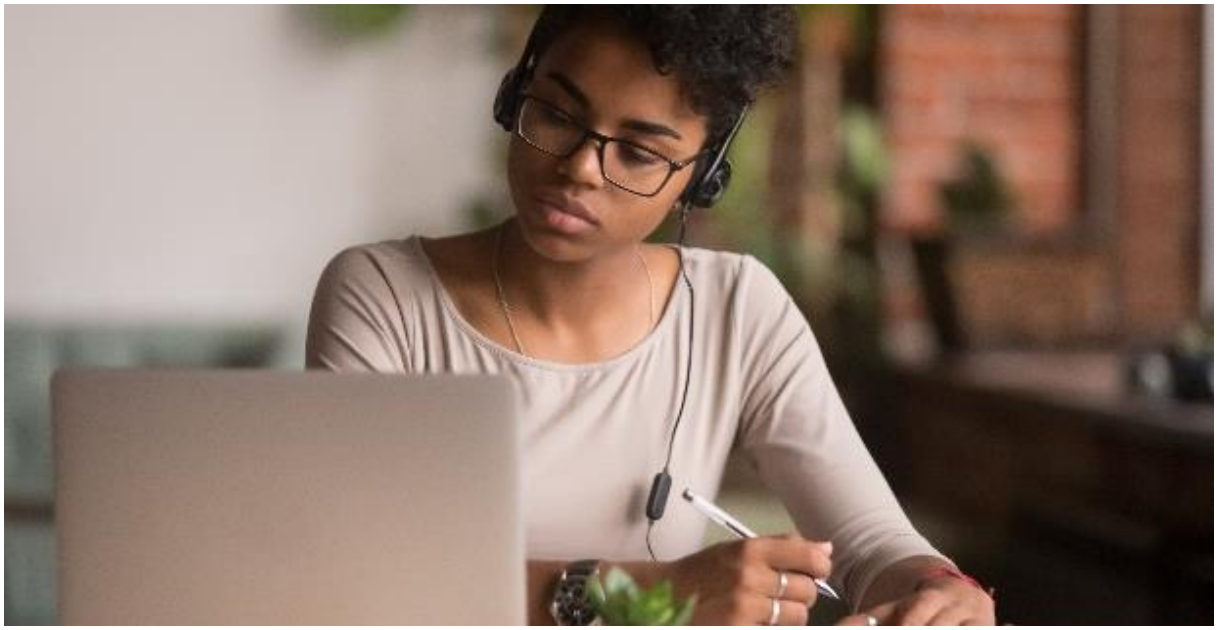
- MinorHealthyCereals
- Habit
- Tellspec
- Sugarlogix
- Calxyt

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

NEW METHODS IN EDUCATION

AN ENGAGED AND HEALTHY CONSUMER

FOOD 2030: INNOVATION



From Living Labs to Massive Open Online Courses (MOOCs), from tailor-made webinars to design-sprint hackathons, networks of actors from academia, research, industry and civil society are developing innovative opportunities to attract, develop and empower individuals to lead the transformation of food systems of the future.

SPECIFIC R&I BREAKTHROUGH TOPICS

New models for education: The rise of personalised learning models, Do-It-Yourself opportunities, and interactive learning experiences accounts for the variety of actors interested in learning about food systems. Multi-stakeholder platforms and initiatives that bring together Higher Education Institutions, research and training centres and food companies are increasingly offering cross-disciplinary programmes, MOOCs, Summer Schools, and dedicated study programmes. Students and professionals can bridge fragmented skills and knowledge of food systems and future entrepreneurs can learn how to investigate relevant case studies, and initiate plans for joint business ventures, supply chain innovation and commercialisation.

Awareness of food systems: These emerging education opportunities focus on empowerment: raising awareness of the required changes in the food systems and equipping key audiences with the knowledge, skills and attitudes to play a role, in their own capacity, in food systems transformation. Education in food system thinking allows key actors to understand the societal, environmental and economic demands arising from the different food value chain sectors; identify the full range of intervention strategies available, ranging from technologies and market development to social innovation and adaptive governance regimes; and evaluate the interventions and leverage points where there is an established evidence base demonstrating the likely impact of specific actions. Living Labs, linking citizens with policy makers, scientists, industry representatives and civil society organisations, represent innovative examples of a new, hybrid format for competence-building in this area.

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Innovation and entrepreneurial behaviour: Education providers are increasingly focusing on closing the gap between scientific expertise in the agri-food sector and business skills relevant to reaching the market, so as to enable the practical application of research models and the full absorption of disruptive ideas. Dynamic partnerships between scientists and managers are at the core of the efforts to catalyse food entrepreneurship as a channel to foster knowledge, innovation, and greater societal engagement. Hackathons, events designed to help aspiring entrepreneurs find solutions to pressing challenges in the food system and meet like-minded peers, are examples of new methods to promote and accelerate knowledge and innovation transfer between research, business, and public authorities.

Guidance to Start Ups and SMEs, new models of collaboration and impact: New education methods allow agri-food start-ups to benefit from Business Accelerators and Innovation initiatives, including through mentoring programmes held in partnership with established companies and matching exercises with businesses offering complementary services. Targeted training on innovation capabilities can help SMEs to overcome existing skill gaps and thus unlock untapped market opportunities.

EXPECTED IMPACT

Innovation in education methods will enhance the public's awareness, knowledge, and competences in food systems, by reaching a larger and more diverse audience as compared to traditional, mono-disciplinary learning. Empowered citizens will be able to increase the value perception of food and build a more balanced relationship with industry and authorities across the food chain. Professionals in the agri-food business will gain the necessary expertise to develop healthier products and enhance sustainability through resource stewardship. Start-ups will increase their success rates through a better understanding of their market opportunities and improvements in their business plans.

MARKET OPPORTUNITIES / CHALLENGES

- The rise of flexible and distance learning methods in education cross-cuts education domains and is producing an inflation of products on the market which increases the competition faced by services focusing on food systems transformation.
- As new education methods often rely on digital literacy and infrastructure such as ICT devices and internet connections, their accessibility is limited to certain kind of users, which in turn influences the target groups the new learning experiences are designed for.
- The Covid-19 pandemic has provided a strong boost for experimental education methods and has triggered a new interest in and appetite for learning on food systems and transformative action.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Malnutrition.
- Rise on non-communicable diseases.
- Demographic change.
- Migration.
- Scarcity of natural resources.
- Rise in energy consumption.
- Economic globalisation.
- Agricultural pollution.
- Biodiversity loss.
- Health and food consciousness.
- Responsible consumers.
- Destabilised consumer trust.
- Changing households and food.
- Globalisation of diets.
- Consumer engagement.
- Social media and food.
- New shopping behaviour.
- Food waste recovery up-cycling / waste cooking.
- Women's empowerment.
- Responsible research and innovation.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

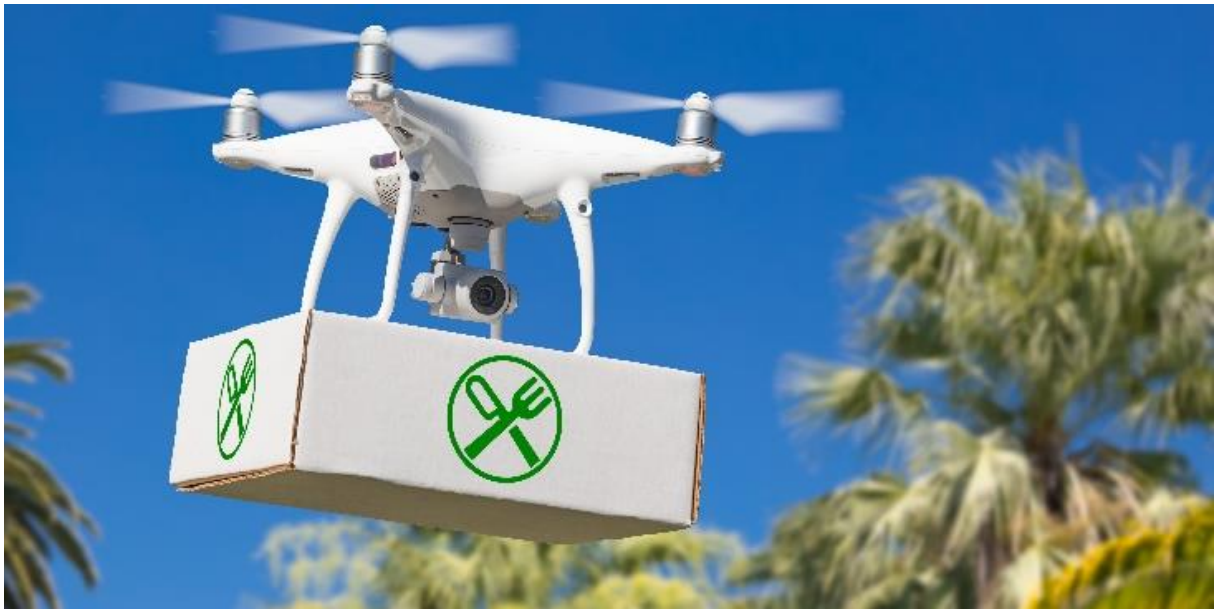
- BallyMaloe Cookery School
- The Plant
- Urban gardening with children
- 81 Forests in 81 Cities (TR)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

LOGISTICS – NEW SYSTEMS

THE TOOLS OF A FUTURE PROOF FOOD SYSTEM

FOOD 2030: CIRCULARITY, INNOVATION



A new way of transporting materials from one place to another globally would change the way we understand trade and the acquisition of goods in a rapid market. New logistical breakthroughs have the potential to contribute to the transition towards more effective supply chains and circular food systems.

SPECIFIC R&I BREAKTHROUGH TOPICS

The Physical Internet: The Physical Internet refers to a radically novel way of sustainable logistics, that could replace the currently unsustainable and too often inefficient global practices of how physical objects are moved, stored, supplied, and used. It draws inspiration from the digital internet to create a global logistical network with high interconnectivity, goods enclosed in smart, eco-friendly, and modular containers, and distributed multi-segmented intermodal transport. Such a smart but complex global system will be challenging to put in place but has large implications for the logistical dimensions of food systems. It requires technological breakthroughs in the design of infrastructure, container handling and transportation, supply chains modes as well as social innovations that transform the practices involved in, for instance, (online) shopping, food delivery and transportation.

Service "at the door at any time": The development that allows consumers to have food delivered to their door at any time is already transforming our logistical practices. It involves the shift towards online shopping and emerging food delivery services that deliver meals or food directly from farmers or supermarkets to citizens. It has severe impacts on traditional ways of organizing catering, restaurants, and retail services. It presents many different challenges and opportunities for rural and urban areas, for new entrepreneurs and more traditional actors (restaurant owners, farmers, supermarkets). While it has the potential to support local and more sustainable food supply chains and provide opportunities for consumers and businesses, it raises questions about the position of vulnerable or marginalized communities and the market position of smaller companies that have to adopt new technologies and practices rapidly to remain competitive.

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EXPECTED IMPACT

New logistical breakthroughs could potentially contribute to the transition towards local supply chains and circular food systems. Such new and high-tech developments could radically change the practices and daily routines of the actors involved in transportation, catering, retail, restaurants, and food production.

MARKET OPPORTUNITIES / CHALLENGES

- Rapid developments in Artificial Intelligence and Big Data Analytics provide opportunities to innovate and implement the technological elements of the Physical Internet, as well as provide a basis for further developing of 'anytime doorstep delivery'.
- Successfully developing the Physical Internet requires global collective action: harmonizing and transforming legal procedures, contract laws, and protocols, as well as significant investments in renewed infrastructures and technologies such as modular containers, distribution stations and information systems.
- Consumer trends might further enhance the market opportunities for delivery services at the door.
- Radical transformations could be at odds with interests of the incumbent logistics sector, and invoke resistance from established actors and organizations.
- Breakthroughs in logistics will also affect the way people in the transportation field live and work. While it offers entrepreneurial opportunities in an emerging market, it might also negatively affect other actors that see their livelihood threatened by such novel practices, such as truck drivers and retail workers.
- The Covid-19 pandemic has accelerated developments towards food service delivery at the door, likely contributing to the capacity of companies (and the broader food systems logistics) to transform towards new logistical systems.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- **Urbanisation.**
- **Demographic change.**
- **Economic globalisation.**
- **Changing households and food.**
- **Consumer engagement.**
- **New shopping behaviour.**
- **Physical Internet.**

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- **eFoodChain**
- **Followfish**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

SMART TRACEABILITY IN THE FOOD SUPPLY CHAIN

THE TOOLS OF A FUTURE PROOF FOOD SYSTEM

FOOD 2030: CIRCULARITY

In the food systems, traceability has become a critical element in supply chain management as it is now considered as a new quality index in the food. Innovation in the use of information and communication technologies is required to provide transparency and trust through the value chain.

SPECIFIC R&I BREAKTHROUGH TOPICS

Industry 4.0 – Digitalisation in food production: The term "Industry 4.0", or the fourth industrial revolution, refers to the use in industrial production of recent and often interconnected digital technologies that enable new and more efficient processes, which in some cases yield new goods and services. Digitization offers enormous potential for all steps in the food supply chain from food production, packaging, food distribution to nutrition. It enables Blockchain technologies to trace the whole food chain and ultimately provide information to consumers regarding the origin of the food products, check the nutritional value or allergic risk of products as well as to check their own health parameters to decide on their daily diets.

Blockchain technology for secure food supply chain: Blockchain technology stores data in blocks, in chronological order, and due to what is considered a mathematical trapdoor, data stored in such a way are impossible to alter or remove. Copies of the chain of blocks - hence the term blockchain - and thereby the information, are distributed among the participants in the network. The copies of the blockchain are then updated when a new block of information is added to the chain.

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EXPECTED IMPACT

Innovations like Blockchain will likely impact the way that food products are sourced, priced, and delivered. It has the potential to monitor social and environmental responsibility, improve provenance information, facilitate mobile payments, credits, and financing, decrease transaction fees, and facilitate real-time management of supply chain transactions in a secure and trustworthy way. Indeed, quick tracing of food products to their source will enhance food authenticity, transparency, and trust in the food value chain.

MARKET OPPORTUNITIES / CHALLENGES

- The available data also creates opportunities for developing products and services based on intelligence. For example, data can be used in predictive models to predict demand and/or success of a product by making use of new insights about correlations and causalities. As a result, business models can change from responsive to risk-based and predictive.

- New business models will emerge with a wider use of smart traceability technologies. Blockchain solutions can reduce market inefficiencies to create more value. Many inherent inefficiencies, such as food waste, are considered a "cost of doing business," but blockchain solutions can reduce total industry costs and create new sources of value. New market entrants could offer "freshness management services," and "product-buyer matching." These new business models, enabled by blockchain can potentially connect the grocery value chain to a new, digitally defined industry-performance standard.

- A main challenge to wider implementation of smart traceability technologies such as Blockchain remains the complexity of the food systems. For a typical agricultural production site, implementing blockchain technology requires a customized system and streamlined practices for data entry. Agricultural products have various forms, storage methods, handling processes, and a variety of data recording methods. Thus implementing blockchain in scale requires a great effort of customization, thus financial and human resources.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Economic globalisation.
- Blockchain Technology for secure food supply chain.
- Destabilised consumer trust.
- Concentration in food retail markets.
- Food regulation.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- eFoodchain
- followfish
- FOODINTEGRITY
- FreshStrips
- Tellspec.

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A NOVEL APPROACH TO BIOTECHNOLOGY

THE TOOLS OF A FUTURE PROOF FOOD SYSTEM

FOOD 2030: NUTRITION, CIRCULARITY, INNOVATION

Providing adequate nourishment to the growing world population is one of the greatest challenges of this century. As a result, more research is being dedicated to achieving global food security through common and new tools and technologies. This brings also co-benefits to address challenges in climate change and food safety issues. The development of biotechnological tools on the knowledge of genome and its sequencing and modification, opens the possibility of new applications and implementations.

SPECIFIC R&I BREAKTHROUGH TOPICS

Current agricultural practices cannot cope with the increasing demand for food production. Innovative solutions are required to increase productivity and nutritional quality, while ensuring sustainability and environmentally friendly methods. Advancements in food biotechnology such as **genetic engineering and sequencing** have allowed a big step forward, also in **microbiome research and application**. The multidisciplinary field of **synthetic biology** has the potential to deliver novel agri-food applications. The EU defines synthetic biology as the application of science, technology, and engineering to facilitate and accelerate the design, manufacture and/or modification of genetic materials in living organisms (European Commission, 2014). Synthetic biology uses all available technologies for genetic modification also in combination with mathematical modelling and simulation, but in particular aims at faster and easier processes. Both microbiome and synthetic biology research have emerged and became successful from the convergence of multiple disciplines.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

EXPECTED IMPACT

As microbiomes have a key role in human, plant, animal and, ultimately, planetary health, **microbiome technology** has the potential to minimize the environmental footprint, sustainably increase the quality and quantity of farm produce with less resource-based inputs and to positively influence human health. **Synthetic biology** approaches are expected to contribute substantially on improving agricultural productivity, food quality and production, while ideally attaining a sustainable and cost-efficient practice (Roel & Zurbriggen, 2020). Priority objectives of synthetic biology are to improve plant growth, increase crop yield also under difficult conditions such as draught, increase nutritional value, reduce fertilizer usage, or enable photoautotrophic production of pharmaceuticals, food ingredients or biofuels.

MARKET OPPORTUNITIES / CHALLENGES

Biotechnology, knowledge on microbiome and synthetic biology have enormous potential in our modern world, for a wide spectrum of beneficial applications. These include amongst others

- Improving food security by quickly engineering resistant plant types.
- Bioremediation of polluted or contaminated soil and water.
- Provision of secondary metabolites for nutraceutical, pharmaceutical and industrial purposes.
- Use genome engineering of food microbes to increase the impact of food on microbes.
- Increase human, animal, plant or soil health by microbial engineering or selection of beneficial microbes.

Risk issues have been raised in relation to human health, socioeconomic and ethical impacts especially when genome engineering is applied. Public concerns address the uncertainties associated with the long-term impacts on health and environment, including increased allergenicity, as has been the case with genetically modified microorganisms or other novel foods. Novel applications may negatively impact existing supply chains, affecting e.g. traditional producers of plants used for drug supply. Concerns about bioethical concerns have been raised together with the potential for misuse of a technology, implying bioterrorism or bioterror.

EXAMPLE REFERENCES

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Malnutrition.
- Scarcity of natural resources.
- Genome engineering.
- Novel food.
- Natural preservatives and milder processing methods.
- Alternative protein sources.
- Functional foods including pro&prebiotics.
- "Free from" products.
- Food waste recovery up-cycling / waste cooking.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Mosa meat
- Impossible foods
- Ecofeed
- Perfect day
- Geltor
- Toast Ale
- Kiverdi
- Finless foods
- Sugarlogix
- MiraculeX
- Memphys Meats
- Clara food

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INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) APPLIED TO FOOD SYSTEMS

THE TOOLS OF A FUTURE PROOF FOOD SYSTEM

FOOD 2030: INNOVATION

The XXI is living the advent of a digital revolution. The spread of mobiles and similar portable technologies, mobile applications and the easy access to the internet is changing social behaviour at a very fast pace. This is affecting also the food system rapidly, where new applications and implementation are being developed in several areas: new sensors, Internet of things, Big data, Industry 4.0, robotics, augmented reality, digital twins, and at the top of the digitalisation concept, artificial intelligence (AI).

SPECIFIC R&I BREAKTHROUGH TOPICS

Full exploitation of big data: Data is the backbone of digitalisation; therefore much development is needed in the food system to research how data is acquired, stored, processed, analysed and utilised. But also social challenges arise: Transparency of data, integrity of data, validity of data, ownership of data and ethics.

Internet of Things (IoT): The IoT refers to the interconnectivity between machines and devises. Much of the development in the sector depends on this factor, which still requires research for a full exploitation of digital technologies.

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New sensors applied to multiple applications: Sensors are also critical for the acquisition of data. Great developments are being advanced in smaller, resistant, and accurate sensors, which are the starting point for many digital applications, including biosensors.

Digitalisation of industry: The so-called Factory 4.0, starts by integrating sensor technology, data management, IoT, robotics, digital twins, and artificial technology for a more precise, efficient, and sustainable way of producing. In the food sector, many challenges arise as the source are living materials with many changing parameters, usually controlled by humans.

Robotics: Part of the greatest developments in some food sectors is due to advanced robots. Robots substitute humans in tedious and repetitive jobs, frequently adding precision and speed.

Augmented reality and digital twins: These technologies allow for simulations in almost a real replica of a process. It allows for a better use of resources, smaller times for development and better design.

Artificial intelligence (AI): Considered the paramount of digitalisation, it consists of creating algorithms that allows advance and "intelligent" processes in machines. It is the next step in robotics and mechanisation of processes, allowing for operations that not even humans could achieve.

EXPECTED IMPACT

Transversal to many sectors in the food system, from the efficiency of industrial processes to new business models in the interaction with consumers, the ICT applications and digitalisation is an occurring breakthrough in other sectors that is waiting its full development in the food agri-food sector. It affects the way food is produced, processed, distributed, and consumed and it has an impact that reaches deep social, economic, and environmental changes. Much technology has been developed in other sectors and is waiting for the right maturity in the agri-food sector to achieve its full potential.

MARKET OPPORTUNITIES / CHALLENGES

- Many technological advances are provided from other sectors and much of the effort in the agri-food sector is depending on the development and implementation of such technologies.
- There is a gap between the current skills and the needed skills in workers to adopt many new digital technologies. The skills gap is both a barrier and an enabler, a barrier to the current workforce and systems in place, but an opportunity to upgrade talents and to attract a younger generation.
- There is an ongoing investment from the public and private sector in digitalisation, there is a political will and a social preparedness to adopt many of the incoming innovation.
- Environmental sustainability might also benefit from adoption of digitalisation, processes become more efficient, there is an optimisation of resource uses, and there could be advances at citizen level, such as a more coherent food waste management for example.

EXAMPLE REFERENCES

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No774088

ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Industry 4.0 - Digitisation in food industry.
- Big data analysis.
- New and game-changing digital technologies in agriculture.
- Blockchain technology for secure food supply chain.
- Consumer engagement.
- Social media and food.
- New shopping behaviour.
- Physical internet.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Rethink Recourse
- eFoodChain
- Fhytl Signs
- Winnow
- Flourish
- Starling
- Ida by connecterra
- AutomonPH by Waterice
- Iron Ox

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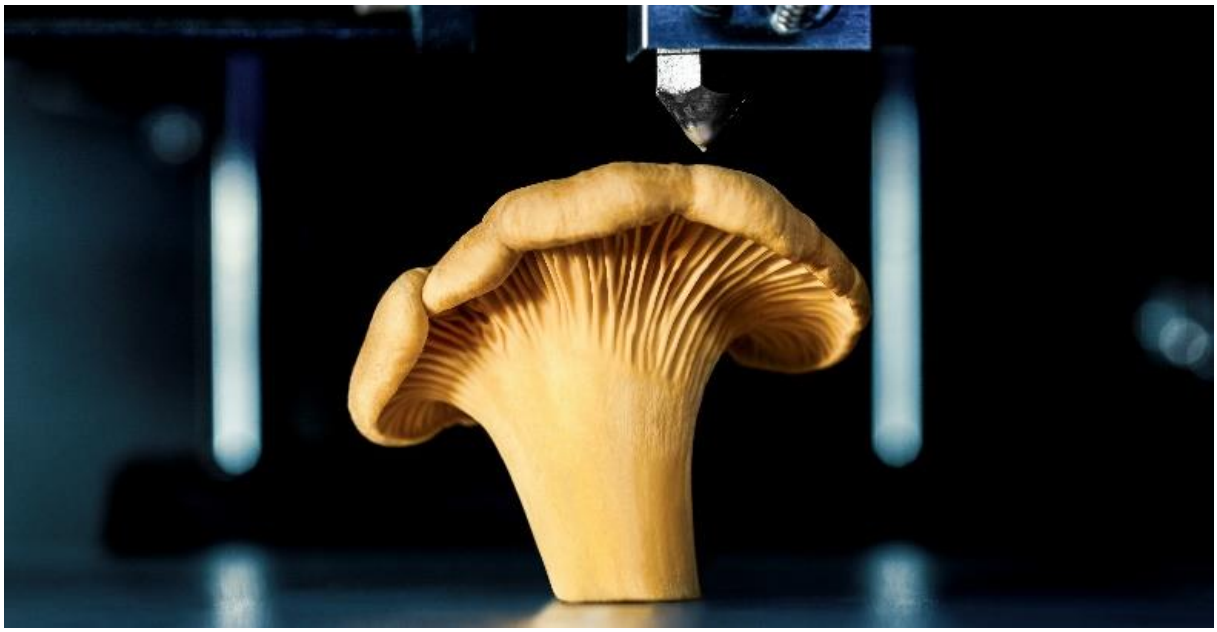
FOOD INDUSTRY 4.0 – NOVEL AND EFFICIENT FOOD PROCESSING

THE TOOLS OF A FUTURE PROOF FOOD SYSTEM

FOOD 2030: NUTRITION, CIRCULARITY, INNOVATION



New approaches for sourcing, processing, and manufacturing systems for foods and food ingredients are constantly on the rise. While several sector-specific technologies are emerging, common goals across this innovation area include reducing environmental impact and increasing nutritional quality while maintaining food safety and the enjoyable experience of consuming food.

SPECIFIC R&I BREAKTHROUGH TOPICS

Novel and efficient food processing includes all steps from cutting, fractionation and separation of agro- and aqua resources, structuration and stabilization of new food structures and products, assembling of meals, and home cooking. In all stages, new innovations have been taking place from cutting technologies (water-beam, laser, ultrasound), fractionation, separation and extraction (dry bio-refineries, membranes, adsorption technologies, electrostatic separation, hypercritical CO2), structuring (emulgation utilizing membranes, microfluidisation, ultrasound), heating (super-heated steam, microwaves, induction, sous-vide, radio-frequency), 'non-thermal and mild' preservation (electromagnetic energy & pulsed electric fields, high pressure treatment, reverse osmosis, cold plasma), filling (Aseptic filling, clean room tech, super cooling), and packaging (see packaging breakthrough). For illustration, 'non thermal and mild' preservation technologies like high pressure treatment are under development to maintain the fresh-like quality of pasteurized and sterilized food as well as possible due to short and mild processing times while also reducing energy input during processing. Dry biorefineries have a potential to separate and valorise the different fractions of resources already in the agricultural production environment.

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The processing innovations have also been and will be fuelled by new developments in digitalization & robotisation & 3D-printing (Personalisation, Mass production, DIY), nanotechnologies (new formulations, new applications, novel packaging, novel foods, policies applied), system thinking (low input technologies, feedback and feedforward controls, novel sensing methods, etc.), new ways of producing resources (e.g. via organic production, agro-ecological principles, urban or coastal farming and so on) and of consumption practices (e.g. consumer attitudes towards products and technologies, participatory actions, new food preparation schemes, food cultural heritage, etc.).

EXPECTED IMPACT

There have been numerous innovations in the food processing technologies in recent times, many of which are sector specific. In general terms, the Food industry 4.0 strives to provide more efficient processes in productivity, energy and water consumption, innovative processes targeted for a wider variety of foods including traditional foods, more environmentally sustainable processes and less production of waste, or products of higher nutritional quality and targeted meal compositions. In many cases it also implies higher productivity or lower production costs. It should be noted that such considerations should go hand in hand with the notion of maintaining as well as possible the naturally rich and diverse quality characteristics of resources, hence without artificial interventions or over-dimensioned manufacturing steps.

MARKET OPPORTUNITIES / CHALLENGES

- All processing equipment's that require les inputs and avoid losses are supporting more eco-friendly manufacturing.
- Highly flexible technologies that can be used for either delocalization and scaling of processing (in the field, at home) or in the time.
- Reverse engineering tools that will use as starting point for manufacturing the consumer preferences and needs. Also new participatory co-creation pathways can be elaborated on which brings producers and consumers closer together.
- Digitalization of processing, utilization of artificial intelligence in order to help actors in making environmentally best choices and in steering manufacturing processes in time, and to help consumers to get insights in food processing; this is a typical cross-sector operation.
- Food fermentation technologies due to increasing insights in microbiology that permit to develop new healthy and sustainable products.
- Revival of artisanal and local food processing schemes that enhances the richness of the European Food Culture and all its actors.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Rise in energy consumption.
- Industry 4.0 - Digitalisation in food production.
- Big data analysis.
- New technologies in food production.
- High/Ultra processed food.
- Novel food.
- Natural preservatives and milder processing methods.
- "Free from" products.
- Packaging 4.0.

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- Food waste recovery up-cycling / waste cooking.
- Food regulation.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Apeel
- Doux Matok
- Geltor
- Toast Ale
- Kiverdi
- Ecoberries by CoreOrganic

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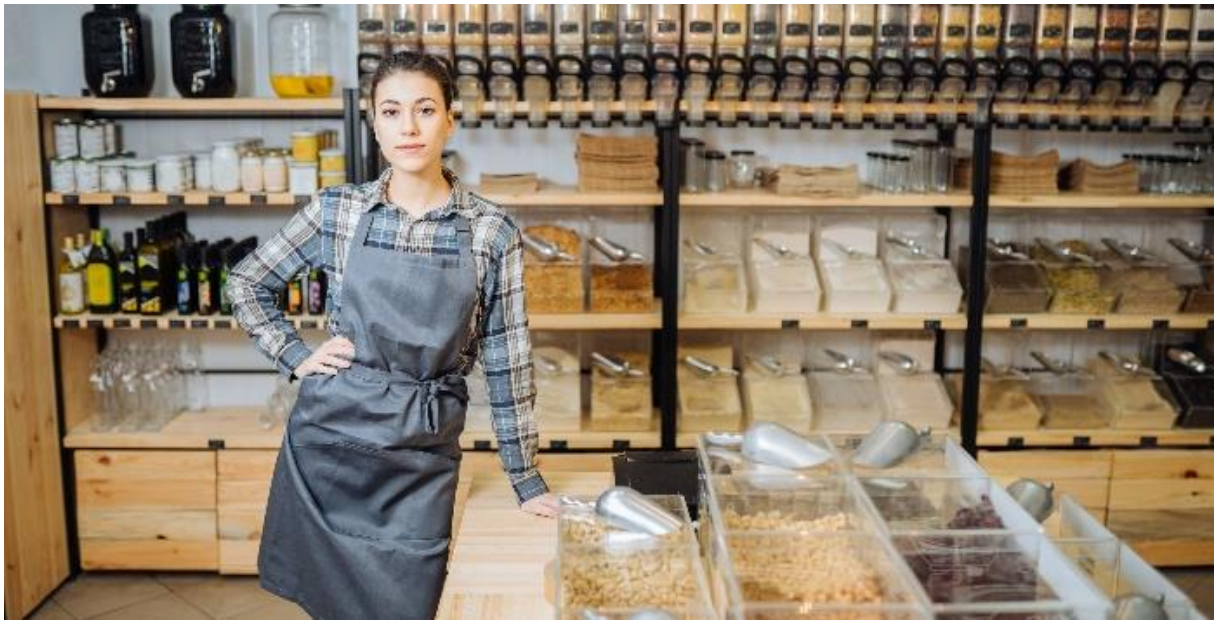
SUSTAINABLE PACKAGING

THE TOOLS OF A FUTURE PROOF FOOD SYSTEM

FOOD 2030: CLIMATE, CIRCULARITY



Sustainable packaging optimises the use of recycled and renewable materials to minimise its ecological footprint and environmental impact. It has to be beneficial and safe for consumers, maximise efficiency, minimise waste generation, and meet market criteria for both performance and cost.

SPECIFIC R&I BREAKTHROUGH TOPICS

New materials: Besides polyethylene terephthalate (PET) and polypropylene, chitosan and polyhydroxyalkanoates (PHAs) are being used as polymers to substitute conventional biodegradable plastics for the packaging industry. The so-called Intelligent Packaging (consisting of materials that monitor food conditions and/or the surrounding environment where food packages are stored) is also gaining relevance in the packaging scenario.

Biodegradable materials: There are fully recyclable plant-based materials available from food side-streams such as sugar cane, maize, corn, mushroom roots, seaweed agar, potato starch, cellulose pulp, palm leaf, and beeswax. In addition, some original innovations put in place are organic packages from agro-industrial by products that are re-usable (e.g. compostable food packages containing seeds to be planted) or even edible (e.g. packages made of nuts, dried fruits and seeds).

New recycling methods: Some innovations in the field of polymer recycling are solvent extraction, the conversion of plastic into fuel (using mixed polymer waste that are otherwise difficult to recycle) and depolymerisation, where the polymer is broken down into raw materials or useful chemical intermediates. Anaerobic digestion is an innovative form of recycling that decomposes organic material and turns it into energy.

Reduction of package: Several steps are being made to minimize packaging volume and weight, including product/packaging ratio, remove unnecessary components or layers (e.g. turning plastic pasta/baked goods bags into recycled paper ones), without sacrificing products' safety. One of the most innovative packaging

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solutions are the “disappearing” ones, designed in a way for which products are assembled so that they do not need packaging at all, or the box where they are contained can be water-soluble.

New models in the food system: Design thinking is now emerging in the packaging field to elaborate innovative food packaging systems that minimise the use of resources, while being in harmony with shelf life and distribution conditions, as well as consumer food purchase and consumption behaviour.

EXPECTED IMPACT

Higher sustainability of the food system, less environmental impact, better use of resources and waste streams. More sustainable food packaging can improve food safety by reducing bacterial contamination, prolonging shelf life, ensuring convenience in food distribution and handling.

MARKET OPPORTUNITIES / CHALLENGES

- The spread of e-commerce could place a focus on increased packaging requirements.
- Retailers could require ever-longer shelf lives for food products, which could create more niches for smart sustainable packaging technologies.
- Data protection remains a delicate challenge to be faced when consumer behaviour and purchasing habits are concerned.
- Developing sustainable packaging is a multidisciplinary challenge, integrating the packaging industry, logistics, retailers, and primary producers; therefore, a systemic and collaborative approach is required to reach the sustainability goal.
- Consumers and society at large may have different and conflicting conceptions of what is considered sustainable in terms of packaging; thus, finding the appropriate trade-off represents a challenge itself.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Scarcity of natural resources.
- New shopping behaviour.
- Responsible consumers.
- Biobased packaging.
- Packaging 4.0.
- Reduction of plastic packaging.
- Packaging and health.
- Food waste recovery up-cycling / waste cooking.
- Food regulation.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Mimica Touch
- TIPA
- BeeBee Wraps
- Eco-Kiddles
- NanoPack
- Novell Compatible coffee capsules#
- Skipping Rocks Lab
- SusFoFlex
- YPACK
- Ecoberries by CoreOrganic

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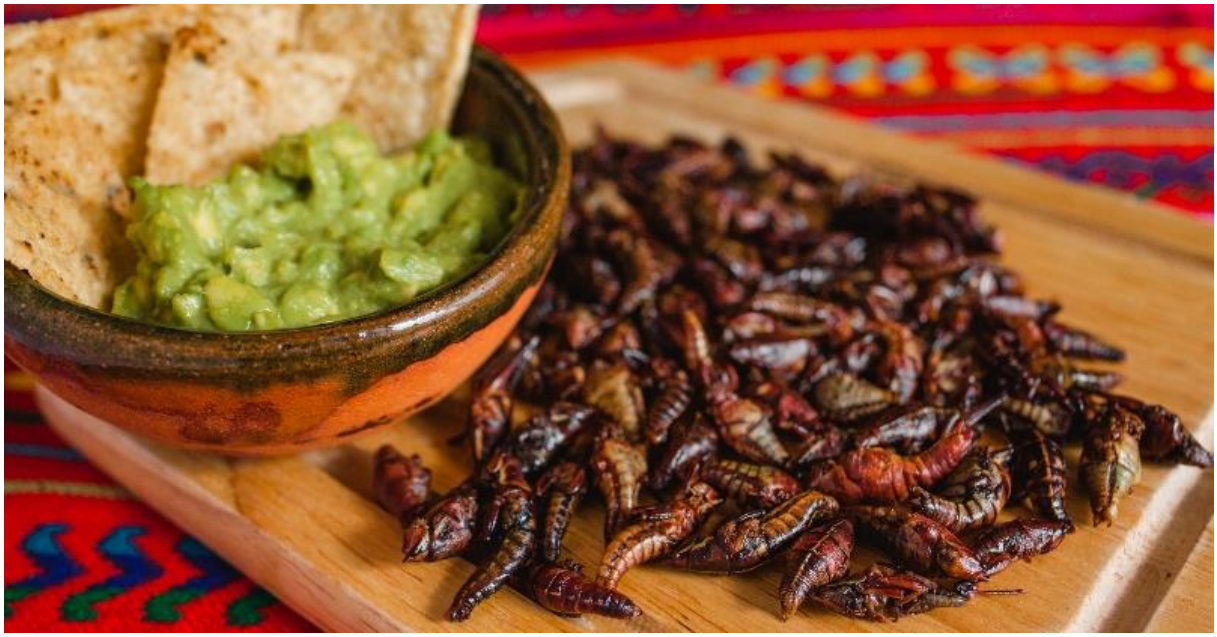
DIVERSITY IN THE DIET

THE TOOLS OF A FUTURE PROOF FOOD SYSTEM

FOOD 2030: NUTRITION, CLIMATE, CIRCULARITY, INNOVATION



One of the key challenges for future food security is meeting the demands for sustainable sourcing of food whilst a demographic increase is expected. One way to obtain food is to increase the diversity of food sources using new raw materials, examples of this are new harvests of high productivity/low environmental impact such as marine sources (algae) and insects. Other ways might be the fermentation of side-streams or cultivating animal cells in a laboratory.

SPECIFIC R&I BREAKTHROUGH TOPICS

New sources not fully exploited: There are diverse varieties of animal, plant and fungi species not fully exploited. One example could be the use of legumes, which some cultures use in their daily diets. There is still space for full exploitation of such already available sources. Also, the food production and processing produce large quantities of unused side-streams which frequently end composted or combusted. Those could be converted to food using fermentation processes using biotechnology, novel fungi, food bacteria and yeasts or using refining processes.

Full exploitation of marine resources: The sea provides algae, seaweed and krill which are produced in abundance with a low impact in the environment. Harvesting those resources in a controlled manner and working with consumer for acceptance of many of these resources could provide new raw materials with a low environmental impact.

Full exploitation of insects: The non-cordate phyla of arthropods, which includes insects, crustaceans, myriapods, and others, are a good source of protein. They provide very fast protein production under supposedly low environmental costs. Although used by some cultures, they are not mainstream. The consumer acceptance, environmental impact, and food safety are still challenging in this research.

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Cultured meat and cellular aquaculture: Cultured meat is the name of laboratory meat, or in-vitro cell culture. Animal cells that are replicated through a laboratory process. Theoretically, there is less environmental impact and no issues of animal welfare. Large investments are already ongoing on those technologies, but consumer acceptance and sustainability parameters are still under research.

EXPECTED IMPACT

Exploring new raw materials allows a higher diversity on use of resources, technological applications, and health impact on consumers. The use of lower organisms can provide higher efficiency in food production whilst reducing the use of higher organisms that contribute largely to the water use, land use and loss of biodiversity. The use of side-streams increases the efficiency of the overall food systems value chain. Additionally, the research on new raw materials opens a new market to consumers, new nutrients to explore, provides new sources of jobs and increases the resilience of the food system towards food security. It also provides diversity into the diets of consumers, providing ground for healthier diets as well as increase food security.

MARKET OPPORTUNITIES / CHALLENGES

- Exploring new resources provides resilience to the food system.
- Often, some of these new raw materials provides less environmental burden to the production and processing, reducing the environmental footprint.
- It opens the opportunity to new markets and business models, but sometimes it replaces other markets (e.g. cultured meat vs. cattle production). Therefore this could be seen both as an opportunity and a challenge
- It provides the opportunity to open the door to new nutrients and sensorial properties to the diet.
- Consumer acceptance and cultural changes might be a challenge in most of the cases. There are challenges in the current consumer perception of this new sources, but also in the uptake of future generations of some of the described concepts.
- Some of these new raw materials require further research to overcome issues such as food allergies in insects, efficiency in cultured meat or legislation and labelling to be applied to the final products.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Malnutrition.
- Scarcity of natural resources.
- Cultured / in vitro meat.
- Novel food.
- Alternative protein sources.
- Health and food conscioiusness.
- Special diets like vegetarian, vegan or low carb.
- Globalisation of diets.
- Food regulation.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Mosa meat
- Entomo farm
- Impossible foods
- Agriprotein
- Allmicroalgae
- Ultima Restaurant
- Perfect day
- Finless foods
- Memphys meats
- Beyond meats
- Clara foods
- New Wave Foods

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THE GLOBAL FOOD ANALYSIS

THE TOOLS OF A FUTURE PROOF FOOD SYSTEM

FOOD 2030: INNOVATION

The robustness of the scientific data is the basis for the risk assessment of chemical (toxicological) and microbial contaminants. The rapid expansion of scientific and technological advances could allow faster and more specific methods increasing decision making but also meeting the societal demands on reducing animal testing.

SPECIFIC R&I BREAKTHROUGH TOPICS

The rapid advances in science, particularly in genomics and epigenetics (the science that deals with the study of genomes and the translation into phenotypes, the expression of gens) and the advances in technology, such as the analytical equipment (e.g. spectroscopy), computational toxicology, bioinformatics and the emergence of Big Data, allows to a new era of food analysis for quality and safety. These new technologies allow the development of:

- Technologies for analysis that are rapid, exact, low cost or non-destructive of samples (e.g. allergen detectors).
- Methodologies for higher traceability and fraud detection.
- Systems for the identification of potential targets for preservation.
- Better modelling for higher accuracy on the potential shelf-life of products (i.e. increasing food security and reducing food waste).

In addition, it could be aspired to reach the demand from the society on reducing animal tests for the safety assessment of ingredients and foods.

EXPECTED IMPACT

The food analysis methodologies applied in Europe are advanced, allowing one of the best food safety and quality systems of the world. Nevertheless, the evolvement of new technologies in the sector can launch a new

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era of rapid, unambiguous, low cost, robust and sustainable food analysis and risk assessment that can improve the way we process, storage, transport and consume food. From the traceability of the ingredients or the rapid detection of allergens to the increase of the self-life of products (reducing food waste) or reduction of animal testing in food risk assessment.

MARKET OPPORTUNITIES / CHALLENGES

- Accurate food safety and quality is a must for the development of the UN Sustainable development goals and the sustainability of the food system, including food security.
- There is already science and technology available that requires further development and application. Targeted R&I investments and support are needed to achieve the full potential of these new technologies.
- The global differences on the management of food safety and quality is a challenge to overcome. Homogenisation of regulation and availability of resources is needed for a world of international trade.
- Communication in food safety and risk assessment towards consumers, the management of social media, and education in the topic is a challenge with an opportunity for improvement to gain citizen's trust.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Agricultural pollution.
- Transboundary pests and diseases.
- Destabilised consumer trust.
- Social media and food.
- Packaging and health.
- Responsible research and innovation.
- Food regulation.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Tellspec
- Foodintegrity
- Mimica Touch
- Viro Vet

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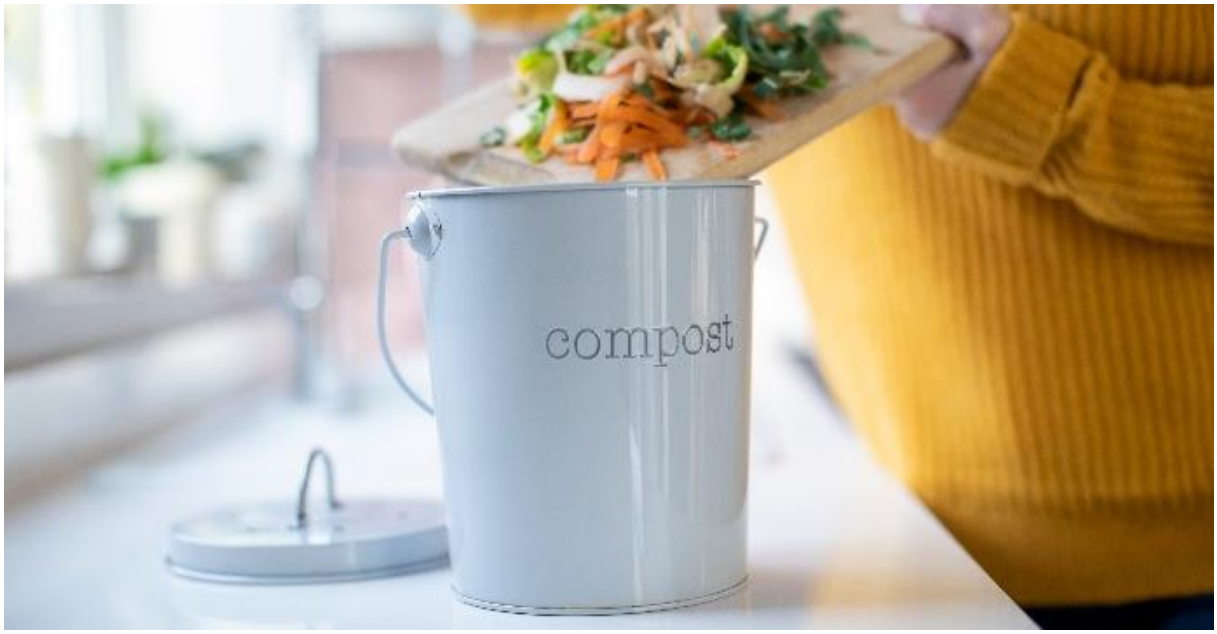
CIRCULARITY IN FOOD SYSTEMS

A SUSTAINABLE AND DYNAMIC VALUE-BASED FOOD SYSTEM

FOOD 2030: CIRCULARITY



The shift from linear processing and consumption of products to a sustainable economy which is regenerative by design requires disruptive innovation to allow for reduced fossil fuel use and food waste, enhanced resource use efficiency and an increased rate of recycling with the aim to retain as much value as possible all across the food supply chain.

SPECIFIC R&I BREAKTHROUGH TOPICS

Reduction of waste: By using innovative technology and AI to measure the scale and incidence of their food waste, aware and organised consumers as well as food service providers can take action by adjusting levels or purchase and establishing networks of food donations and exchange. Innovative solutions are also crucial to reduce post-harvest food loss and extend the life of fresh products, for example through the use of sun-powered climatized stocking sites that protect perishable crops or producing resistant, bio-degradable packages enhancing vegetables' resistance.

New uses of waste: Wilting produce can be used in soups, as well as ripe fruit in fresh smoothies. New techniques allow to convert food scraps into organic fertilizer, compostable bioplastics, biofuels, and renewable energy. As landfills run out of space, an increasing number of towns are diverting food waste to compost facilities, using the end product to restore depleted soil.

New recycling business models: An increasing number of start-ups is successfully making a business out of food waste conversion into renewable energy and other products through a biological process called anaerobic digestion. Innovative companies are integrating worms and larvae in their economic cycles, so as to produce animal feed and organic fertilisers from waste. Entrepreneurs in areas such as coffee and beer brewing are adding new services to their core businesses, such as the production of organic mushrooms from coffee grains and energy bars from spent cereals.

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New structure in food system: Innovative solutions designed at the consumer and producer/processer/retailer levels require an enabling regulatory environment to produce large-scale positive effects. Policies can make use of incentives, regulation, and coordination to address the effects of action against food waste on winners and losers, for example by ensuring to compensate excessive costs for the transition in specific parts of the food chain. Food waste reduction priorities are also increasingly integrated into cross-sectorial policies, for example through legislation adding food waste to the list of mandatory recyclables.

EXPECTED IMPACT

Circularity holds the potential to change the food production, processing, and consumption patterns. In the social domain, circular economy can stimulate growth in high-skilled employment and job creation in areas where unemployment is high. In the economic domain, it can provide new business investment opportunities and produce a positive impact on GDP. Regarding the environment, circularity in food systems can lead to reduced extraction and use of natural resources, decreased GHG emissions and primary material consumption, reduced land-use and fresh water use savings.

MARKET OPPORTUNITIES / CHALLENGES

- Financial institutions have the opportunity to provide innovative loan packages to smallholder farmers, while the latter can benefit from low interest rates thanks to public incentives.
- Waste management enterprises can expand their activities so as to incorporate reuse of material into their core business models.
- Lack of infrastructure, expertise and/or collaboration throughout the food chain can hinder absorption of innovative practices at the system level.
- The market share held by circular business models is limited. For example, food start-ups circular services are often confronted with a lack of real market demand in the absence of anti-food waste regulation.
- Status quo biases that are still inherent in investments and consumer behaviour can slow down the implementation of circular business models.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Climate change.
- Urbanisation.
- Demographic change.
- Scarcity of natural resources.
- Economic globalisation.
- Health and food consciousness.
- Responsible consumers.
- Biobased packaging.
- Packaging 4.0.
- Reduction of plastic packaging.
- Food waste recovery up-cycling / waste cooking.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Feeding the 5000
- Foodwin project
- GrowUp urban farms
- Rethink Resource
- Ultima Restaurant
- Winnow
- The Plant
- Fareshare
- Ostara
- KromKrommer
- Ecofeed
- Toast Ale
- Smart floating farm
- TIPA
- Eat me (AT)

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EFFICIENT USE OF RESOURCES

A SUSTAINABLE AND DYNAMIC VALUE-BASED FOOD SYSTEM

FOOD 2030: CIRCULARITY

Optimisation of our processes from agricultural input up to consumer behaviour is relevant for the overall sustainability of the food system. Such optimisation does not necessarily require further intensification of production, but rather involves significant reconfiguration of many different dominant practices and structures that constitute our food systems.

SPECIFIC R&I BREAKTHROUGH TOPICS

Efficient use of water: global agricultural production currently uses about 70% of the world fresh water supply. Optimizing and transforming the way water is used in food systems requires technological innovations reducing water losses as well as optimizing irrigation and food processing, but also transformative interventions that address water scarcity in vulnerable areas, innovations and interventions that reduce and prevent water pollution, as well as new farming (management) methods that lead to more resilient soils and production systems, and enhance adaptivity and sustainability of the food-water-energy nexus.

Efficient use of land: increasing demand for food has led to increasing pressure on and competition for land. Optimizing and balancing land-use activities is a critical topic in the transformation of food systems. Efficient land-use can be achieved through (high-tech) innovations (increasing crop yields, vertical farming) that lead to more efficient production, but not necessarily requires intensification of agricultural practices. Instead, moving away from monocultural production and intensive livestock farming, but increasing crop diversity and implementing new innovative practices that combine land-use functionalities (such as agroecology, conservation agriculture, integrated crop-livestock systems and urban agriculture) might pave the way for transformations towards more local, (bio)diverse and resilient food systems.

Efficient use of nutrients: current nutrition efficiency in food systems is hampered by ineffective and large-scale use of fertilizers (in monocultural production) including the adverse effects of this usage on the environment,

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and large quantities of food waste throughout the value chains. Innovations and interventions are required that enhance nutrient circularity (in particular in nitrogen and phosphorus cycles), improved livestock and manure management as well as innovations that reduce food waste throughout the value chain. Efficient use of nutrients could be further enhanced through the transition towards plant-based diets, thereby also accommodating more efficient usage of water and land.

Efficient use of energy: more efficient energy use in food systems could be achieved through optimizing energy use throughout the entire value chain. This means for instance moving towards the use and scaling-up of sustainable and renewable energy sources in food production, but also redesigning and innovating industrial food processing. Furthermore, it requires the optimization of logistical processes, which includes experimenting and innovating towards shorter supply chains and local food systems in order to reduce carbon emissions.

EXPECTED IMPACT

Optimisation of our processes from agricultural input up to consumer behaviour is relevant for the overall sustainability of the food system. The impact on the way we produce, process, distribute and consume food will therefore be very significant, as well as the impact such reconfiguration will have on biodiversity, climate change, human health, and economies and societies more broadly.

MARKET OPPORTUNITIES / CHALLENGES

- Increasing awareness of the need to protect the environment, enhance soil quality, reduce pollution, and restore biodiversity is an opportunity to reconsider current land, water, nutrient and energy use practices.
- (Local) governments are increasingly facilitating experimenting with non-conventional production methods that aim to alter land and water use practices and move towards local supply chains.
- Further optimization of water use in agricultural production might technologically be challenging.
- Lack of infrastructure, expertise and/or collaboration throughout the food chain can hinder absorption of innovative practices at the system level, while incumbent actors and institutions might seriously hinder the uptake of radically novel practices.
- More institutional and financial support is needed to engage and facilitate farmers in the uptake and upscaling of novel innovations that might lead to optimization of land, water, nutrient and energy use.

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Urbanisation.
- Scarcity of natural resources.
- Rise in energy consumption.
- Economic globalisation.
- New and game-changing digital technologies in agriculture.
- Changes in farm structures.
- Agricultural pollution.
- Biodiversity loss.
- Urban agriculture / urban farming.
- Consumer engagement

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Kipster
- High tech Green House 2020
- NoviFarm
- Soilfood
- Recare
- Ostara
- Bioward Planty Organics
- Kiverdi
- Agrophotovoltaics from Fraunhofer
- Farmers cut
- EggXYt
- Beeflow

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- Urban Beekeepers (AT)
- Bee urban (SE)

FOOD FOR SOCIETY

A SUSTAINABLE AND DYNAMIC VALUE-BASED FOOD SYSTEM

FOOD 2030: CIRCULARITY, INNOVATION

Access to safe, nutritious, affordable, and sufficient food is key to provide rural and urban communities with good health, sustainable jobs, and self-fulfilment. To achieve food & nutrition security (FNS), it is necessary to tackle global challenges such as population growth, resource scarcity and urbanization by making food systems sustainable, resilient, diverse, inclusive, and competitive for the benefit of society.

SPECIFIC R&I BREAKTHROUGH TOPICS

Community driven social innovations: Climate change, global trade unbalances and the related ensuing food insecurity are affecting specific societal groups differently. Local communities are reacting faster to the specific challenges needs and vulnerable groups are confronted with as compared to other levels of governance. In Europe, communities are fostering social innovation through citizen participation to research, City Labs, and citizen science, as well as agricultural practices such as urban cropping, urban keeping, and Community-Supported Agriculture.

Green public procurement: Public authorities are major consumers largely participating to and influencing the shaping of market practices and norms in the food systems. Green public procurement - focusing on the provision of nutritious and sustainable meals for schools, hospitals, elderly people residences and public administrations' canteens – can help stimulate a critical mass of demand for more sustainable goods and services which otherwise would be difficult to get onto the market.

Social entrepreneurship: Many entrepreneurs are adapting their business models to the changing policy landscape and consumers' preferences to reflect an increasing concern for health, social and environmental considerations. Social enterprises focus on food as a public good, instead of solely considering profit, thus incorporating issues such as fair trade, reduction of waste and fair treatment of laborers into their models.

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Awareness of waste in social context: While reducing food waste is of great interest to the vast majority of food systems' actors, Europe is starting to realise the scale of the problem and its economic and environmental impacts. Increasing awareness and modifying certain beliefs related to the size of portions, colour and aspect of food is needed to reduce the amount of waste that is produced in restaurants, schools and, more significantly, households. Innovative initiatives include communication campaigns aimed at overcoming the stigma of use of leftovers in the kitchen, cooking workshops on how to convert wilted vegetables into soups and smoothies, creation of apps and database fostering donation of edible fractions to social services or use to produce bio-fuels or biopolymers.

Trade and consumption norms: The influence of the advertising industry has long encouraged producers, processers, retailers, and consumers across the supply chain to select or discard food solely upon considerations on its aspect and shape. The urgent shift towards imperfect or less processed food as a more 'natural' option bears potential to gradually push the market to value food for its nutrition properties. The awareness of eco-social and environmental impact is increasingly leading to rethinking trade and consumption norms, thus having a positive effect on citizens' health and wellbeing, as well as the amount of production of waste.

Traditions & Do It Yourself (DIY): Consumers show increasing interest in products that are perceived to align as closely as possible with their own traditional cultures. Reacting to the loss of trust in the food industry, consumers are gradually resorting to DYI as a way to access food which values sustainability, authenticity, ethics ad that satisfies emotional and social needs.

EXPECTED IMPACT

The development, diffusion and use of innovation towards food systems transformation occur within the society and in interaction with social relations, practices, norms, and values. As systemic change invariably produces winners and losers, public authorities will need to ensure that innovation in the food system is environmentally sustainable, as well as socially and economically just and safe, especially with regard to the most vulnerable social groups. This may be achieved by reorganising innovation as a social and collective learning process with the purpose of the co-design and implementation of solutions to common grand challenges and the ultimate objective to improve society through the provision of a fundamental public good such as safe, nutritious and affordable food.

MARKET OPPORTUNITIES / CHALLENGES

- Vested interests across the supply chain and institutional resistance to systemic change may hinder the absorption of social innovations by the Single Market
- Structural limitations to Green Public Procurement linked to the small size of public authorities at the local and national levels can be overcome by the support of European initiatives
- While market opportunities exist for social entrepreneurs, innovative start-ups are often driven out of the market by a lack of sufficient demand for their services
- The raise of home-cooking due to anti-Covid-19 lockdown measures taken by many governments represents an excellent opportunity to mainstream DIY practices and build a more conscious relationship between food production, processing, and consumption.
- Ensuring hygiene and safety of food waste recovery e.g. when donating edible fractions or in DIY products

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Urbanisation.
- Demographic change.
- Migration.
- Scarcity of natural resources.
- Rise in energy consumption.
- Economic globalisation.

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- Urban agriculture / urban farming.
- Health and food consciousness.
- Responsible consumers.
- Destabilised consumer trust.
- Consumer engagement.
- Traditions and Do It Yourself.
- Social media and food.
- Food waste recovery up-cycling / waste cooking.
- Women's empowerment.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Feeding the 5000
- Foodwin project
- Losaeter
- Microgardens Dakar
- Fareshare
- Alexandra Rose Charity
- Parkslope Food Coop
- Slowfood Europe

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POLICY (AND MANAGEMENT) WITHIN THE FOOD SYSTEM

A SUSTAINABLE AND DYNAMIC VALUE-BASED FOOD SYSTEM

FOOD 2030: INNOVATION

Since

SPECIFIC R&I BREAKTHROUGH TOPICS

Applying Responsible Research and Innovation (RRI): The principles of RRI imply that societal actors (researchers, citizens, policy makers, business, third sector organizations, etc.) work together during the whole research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society. RRI guides research performing and funding organizations as well as other stakeholders (policy, society, industry) in anticipating the implications of their work, including relevant stakeholders upstream, and reflecting and responding to those stakeholders' concerns and expectations. In this way, co-design, and co-responsibility for the outcomes of research and innovation can be facilitated, increasing societal uptake and acceptability of research and innovation. While the food systems approach strives to provide a comprehensive understanding of food production, consumption and environmental drivers, it is yet less well equipped to shed light on the role of actors, knowledge and power in transformation processes and on the divergent impacts and outcomes of these processes for different actors.

Regional aspects of food system: The role of citizen participation in food system policy making as a key driver is a recognition that solutions to complex challenges in the food system need the active participation of citizens to drive positive change. To achieve this, it is crucial to give citizens the agency in processes of designing policy interventions. Examples of such participatory approaches are local food (policy) councils or citizen assemblies (Doherty et al., 2020). Local and regional innovations in food system governance include food (policy) councils or partnerships—also called local food policy groups (Santo, 2019). There is a widely recognized need to step up the alignment between research and innovation policies at the European, national, regional, and local levels. For wider impact, additional alignment challenges need to be addressed within the realm of R&I policy (i.e.

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multiple sectoral and transversal R&I policies), between (multiple) R&I policies and (multiple) sector policies, and between R&I policy & society (i.e. multiple stakeholder values and expectations).

Impact of Research and Innovation: There is vital potential in research to inform new policy that encapsulates societal sustainability through RRI into food systems thinking (e.g. through mission-oriented innovation systems). This potential relates to supporting policy challenges such as: (1) constructing a resonating policy frame, (ii) formulating policy goals, (iii) involving relevant sectors and levels, (iv) the question of what constitutes optimal policy integration, and (v) designing a consistent mix of policy instruments. Formulating answers to these challenges will enable policymakers and stakeholders to envision the next steps in concretizing integrated food policy (Candel & Pereira 2017). Including RRI perspectives into funding calls and projects refers to research performers and research funders. For researchers, this involves quality criteria for effective integration of RRI perspectives in research and innovation projects. For funders, it involves operationalizing RRI as assessment criteria and key performance indicators in (i) the agenda-setting for programs and projects; (ii) the definition of calls and guidance for applicants; (iii) the review process and grant agreements; (iv) monitoring processes and (v) impact evaluation (source).

Improving the R&I Network: Changes in government policies call for action to build new partnerships and coalitions around holistic transformation agendas. Broader and deeper stakeholder engagement is necessary, including above mentioned citizen-led initiatives but also business-driven approaches for transformative change – integrated value chains, production, and consumption (e.g. circularity).

Higher implementation of knowledge: Existing best practices in food system transformation have the potential for scaling up and out.

EXPECTED IMPACT

Increased public-private collaboration will lead to realizing higher implementation of knowledge and better measurements of impact. Better integrated and holistic approaches.

MARKET OPPORTUNITIES / CHALLENGES

- To complete

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ASSOCIATED TRENDS IN FIT4FOOD2030 (URL)

- Industry 4.0 - Digitisation in food production.
- Big data analysis.
- Novel food.
- Destabilised consumer trust.
- Consumer engagement.
- Social media and food.
- Responsible research and innovation.
- Food regulation.

ASSOCIATED CASES IN FIT4FOOD2030 (URL)

- Baltimore food policy
- Big Picnic

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- Lufa Farms
- Recare
- Starling
- Prohealth
- Roadkill (AT)
- Bybi (DK)

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