



UCD Institute of
Food and Health



STRATEGY 2020-2024

FUTURE-PROOFING GLOBAL FOOD SYSTEMS

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UCD Institute of Food and Health



FOREWORD

The release of this strategy coincides with a time of unprecedented challenges but also many opportunities for our food system. As we deal with the impact of climate change, the growth of the world's population, the potential impacts of Brexit and the ongoing COVID-19 pandemic, we must learn to adapt and to innovate through our scholarship and our research to address these issues. In our new research strategy, we have identified how we will endeavour to rise to these challenges through our research programmes and with the support of our world-class scientists, identify opportunities that may arise. We will do this through our partnerships and collaborations across the university, industry and other academic and research institutions both within the island of Ireland and across the globe.

The UCD Institute of Food and Health's success to date can be attributed to the work and commitment of its members and their research teams and I would like to thank them for their support and dedication in bringing the Institute to this point. I look forward to working with them and all our partners over the next four years of this strategy, in realising our ambition to be a global leader in food and health research.

Professor Dolores O'Riordan

Director, UCD Institute of Food and Health



UCD Institute of
Food and Health

UCD INSTITUTE OF FOOD AND HEALTH STRATEGY 2020-2024

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INTRODUCTION

INTRODUCTION

The UCD Institute of Food and Health has made significant progress in achieving the goals set out in its research roadmap for the period 2014-2019. Some key successes under the goals that were established for that period are outlined below.

1 GOAL 1: To become an international leader in food and health research through successful competition for funding and the development of best-in-class personnel and facilities

The success of any research entity relies on its people and over the past five years we have grown the critical mass of the Institute with the number of Principal Investigators (PIs) increasing from 35 in 2014 to 55 by the end of 2019.

Performance is dependent on resourcing and it has been a successful period for research funding, with €67.9m being won during the term of the last strategy. The top five sources of income in this period have been: Enterprise Ireland (20.3%); Science Foundation Ireland (17.6%); Department of Agriculture, Food and the Marine (€17.2%); Horizon 2020 programmes (14%); and direct industry funding (13.1%). Since 2014, the Institute has led two European Framework projects (FoodRisc and AgroCycle); has been the leading partner in the Enterprise Ireland Technology Centre (Food for Health Ireland) and led the renewed funding of the centre in 2018; has hosted one European Research Council Consolidator Award (Prof Lorraine Brennan) and one European Research Council Starting Award (Dr Aoife Gowen). It has also hosted the largest Enterprise Ireland Innovation Partnership to date through the SAFE (Sequencing Alliance for Food Environments) project led by Prof Seamus Fanning and has led a large, funded industry partnerships through Science Foundation Ireland with the Consus project.

The Institute has shown a significant increase in both the quantity and quality of its research output, particularly in the area of food science and technology. In 2014, the Institute ranked sixth among EU Institutions and 18th globally in terms of research output in the area and fifth and third, respectively, in terms of citation impact. By the end of 2019, the Institute ranked within the top 10 globally for output and No 1 in field-weighted citation impact for food science and technology (Sci Val, Elsevier, accessed December 2019). For five years in a row, Prof Colm O'Donnell has featured among the Web of Science's Most Influential Researchers. This list is a citation analysis of researchers who are among the top 1% most cited in their field. In more recent years, Associate Prof Nigel Brunton and Prof Enda Cummins have joined Prof O'Donnell on this list. This is a remarkable achievement as by international standards the Food Science and Technology group has a relatively small group of researchers.

2 GOAL 2: To increase our relationships and collaborations with leading international research institutions.

From a global perspective, the Institute has been at the forefront of leading international collaborations. Over 53% of its research papers during 2014-2019 have an international collaborator (almost 500 research papers) with a citation impact of 2.27. Among the leading institutions involved in these papers are the South China University of Technology, Institut National de la Recherche Agronomique, Instituto de Salud Carlos III, University of Reading, Technical University of Munich, and the Chinese Academy of Science.

The Institute has also formed strong links with the University of California, Davis, and the China Agricultural University, signing MOUs with each institution and sharing staff and student exchange programmes and other initiatives. Through Prof Lorraine Brennan, links have been established in the area of nutrition with Harvard University School of Public Health.

During this period, we have also had good success through the Fullbright Irish Student and Irish Scholars awards. The strong links we have built with China were evident in winning three Horizon 2020 projects with Sinho partners, namely EU China Safe, Valumics and Agrocycle. The total value of these three projects awarded to UCD was €1.57m.

A key aspect to developing our relationships with industry and European Universities has been our success through the Horizon 2020 programme. This has included the hosting of various workshops under Cost Action proposals. We have had particular success through the Marie Skłodowska Curie International Training Networks, hosting three networks during the period. This has allowed exchange and networking of students and Post-Doctoral staff to partner institutes and organisations across Europe.

3 GOAL 3: To develop educational and training programmes in food and health

One of the key successes for the Institute during 2014-2019 was the delivery of bespoke training programmes for postgraduate students and postdoctoral staff, and the subsequent development of tailored programmes in specific areas for the food industry. The Institute successfully competed for funding for the Agri-Food Development Programme funded under the Department of Agriculture, Food and the Marine and took a leadership role in providing specialist training and development to more than 500 early career researchers over the past five years.

Modules were knowledge based or designed to enhance transferrable skills, which were developed around the Irish Universities Alliance competency framework skills document and framed through conversations with employers to address specific skill requirements of the agri-food sector. Building on the experience of the Agri-Food Development Programme and through the expertise gained during the programme, the Institute developed a bespoke training programme for high-potential managers in the meat industry. The programme was designed to help participants address the global challenges facing the agri-food industry as well as developing key management skills to ensure the graduates would take a leadership role to address these challenges.

In 2017 the Institute was selected by a leading international food company to develop and deliver an online training programme in food safety for its global leadership team. The programme has now been delivered to two cohorts of the industry's global team and it is currently being developed as a Professional Diploma in Food Safety, designed to provide postgraduate training in food safety for individuals currently employed to the broader food sector.

Increasing our interaction with industry has been a key focus over the period of the last strategy. The introduction of "Industry Days" has proved very successful, with the most recent event in June 2019 attracting more than 50 leading national and international food companies.

4 GOAL 4: To translate our research to impact positively on the economy, industry and society

The Institute since its inception has sought to play a role in providing and informing the scientific evidence that underpins the public discourse around food and health issues. It has done this through academic research that drives and strengthens public health messages and initiatives, such as funding through SafeFood for the scientific delivery of its campaigns; the evaluation of the Department of Agriculture, Food and the Marine “Food Dudes” programme; and a lead partner in successive National Dietary Surveys funded under the Department of Agriculture, Food and the Marine, which inform not only policy-makers but industry on the nutritional status of Irish adults and children.

The Institute has also developed a forum through its Policy Workshops to initiate discussions around topical and sometimes controversial areas in food and health such as sugar tax, malnutrition in the elderly and antimicrobial resistance along the food chain. Since 2014 it has held six policy workshops including looking at the role of disruptive technologies by hosting the role of the Internet of Things in the food chain (Internet of Things 4 Food, March 2018).

It has also supported several other international conferences led by Institute PIs across the various research themes of the Institute. The continued relevance of our research to industry is reflected in an increase direct industry funding from 5.5% of total research income in 2009-2013 to 13% in 2014-2018.

5 GOAL 5: To develop and communicate the Institute’s brand to support and underpin the Institute in its work

The expertise of our members in food and health is recognised by their invited participation in national and international steering committees, which drive policy and strategy for government and other agencies. These have included membership of the following:

- Department of Agriculture Food and the Marine Food Wise 2025 Committee (Prof Dolores O’Riordan)
- Safefood Board, Sustainable Healthy Agri-Food Research Plan Committee (Prof Dolores O’Riordan)
- European Federation of Food Science and Technology (EFFoST) Board (Prof Dolores O’Riordan)
- EU Food 2030 policy group and working paper (Prof Lorraine Brennan and Prof Nick Holden)
- Food Safety Authority of Ireland Board (Prof Francis Butler)
- European Food Safety Authority (EFSA) Network on Food Consumption Data (Dr Breige McNulty)
- Joint Programming Initiative - A Healthy Diet for a Healthy Life (JPI HDHL) Scientific Steering Group (Prof Helen Roche)
- Teagasc Advisory Board (Dr Karina Pierce)

The expertise of our PIs is also in demand from the media, who recognise the need for a clear and articulate voice in an ever noisy arena, where an overwhelming amount of information is provided often by those who have little if any training or qualifications in the area. To this end, in 2019 the Institute initiated a series of Public Lectures in Nutrition and Health to help combat some of this misinformation.

Much has been achieved within the 2014-2019 Research Roadmap and this builds the foundations and framework for the new strategy which will bring us into the next decade. The agri-food sector is facing unprecedented global challenges and our strategy is designed to build on our success to date in order to realise research and innovations to tackle these challenges.

KEY ACHIEVEMENTS 2014-2019

INTERNATIONAL LEADER IN FOOD AND HEALTH RESEARCH



No 1
Globally

in field-weighted citation impact for food science and technology (Sci Val, Elsevier, Dec 2019)



Top 10
Globally

for research publication output in the area of food science and technology (Sci Val, Elsevier, Dec 2019)

3

Researchers among world's top 1% of influential scientists

(Web of Science's Most Influential Researchers)



55



Principal Investigators

(up from 35 in 2014)



€67.9m

Research Funding

COLLABORATIONS WITH LEADING INTERNATIONAL RESEARCH INSTITUTIONS

53%

Research papers with international collaborators with citation impact of 2.27



3

Horizon 2020 projects with Sinho partners worth €1.57m to UCD



Strong links with international leaders

including UC Davis, China Agricultural University, and Harvard University School of Public Health.



3

Marie Skłodowska Curie international training networks



EDUCATIONAL AND TRAINING PROGRAMMES IN FOOD AND HEALTH



Specialist training and development

to over 500 early career researchers



Bespoke training for industry

in areas such as food safety and professional development



Industry days

attracting over 50 leading national and international food companies

INTERNATIONAL LEADER IN FOOD AND HEALTH RESEARCH

6 Policy Workshops

13%

of total research income directly from industry in 2014-2018 (up from 5.5% in 2009-2013)

6 Public Lectures in Nutrition & Health in 2019



OPERATING ENVIRONMENT

OPERATING ENVIRONMENT

The Institute’s research focus for the next four years is dependent on the internal UCD environment, the situation nationally and the external global situation. The following summarises these factors.

University College Dublin

The Institute’s strategy is designed to support delivery of UCD’s ambitious Strategy 2020-2024 ‘Rising to the Future’. This strategy, as depicted below, is based around four core objectives, six key enablers and four strategic themes.



The four strategic themes of the UCD Strategy “Rising to the Future” are:

- Creating a sustainable global society
- Transforming through digital technology
- Building a healthy world
- Empowering humanity

All four are very relevant to the core activities of the Institute of Food and Health. They represent an opportunity for the interdisciplinary, co-ordinated research activities of the Institute to tackle some of the greatest world challenges. The Institute will build on its current excellence and expertise to seek innovative solutions to these challenges and continue to develop the science to address emerging and future challenges.

Our research is poised to make a significant impact to UCD Theme 1, by developing sustainable food systems from an economic, environmental and societal perspective and to Theme 3, by generating the knowledge on how new approaches to food production systems and food consumption can benefit both the environment and human health. The Institute plans to use digital transformations to underpin its research outputs consistent with UCD’s Theme 3 and to empower humanity by helping society make better dietary choices to enhance health and wellbeing. Our strategy is poised to deliver on all four

objectives of 'Rising to the Future', with most focus on Objective 1, to increase the quality, quantity and impact of research scholarship and innovation. The Institute will make a significant contribution to three UCD enablers: (i) generation non-exchequer income; (ii) development of faculty and staff; and (iii) recruiting more research postgraduate students through research awards.

National

The agri-food sector is critically important to the modern Irish economy, accounting for 8% of GDP and 10% of exports in value terms; employing 160,000 people; and contributing €26bn to the Irish economy. This contribution is expected to increase to €40bn by 2030. The recognition of the importance of the food industry to Ireland's economy is evident in the national Revised Research Prioritisation Strategy (2018-2023)ⁱ. Food is identified as one of the six key national research themes, with two priority areas: (i) Food for Health, and (ii) Smart and Sustainable Food Production. The Irish government is committed to positioning innovation at the heart of enterprise policy to drive a sustainable economy and to enhance society. In Innovation 2020, the Department of Jobs, Enterprise and Innovation's strategic document, the role of research and education underpinning the competitiveness of Ireland's industry is emphasisedⁱⁱ. In line with this thinking, innovation was identified as a key driver of competitiveness and growth for the Irish agri-food sector. The Department of Agriculture Food and the Marine, in its strategy document, Food Wise 2025, set out a vision for growth of the agri-food industry underpinned by innovationⁱⁱⁱ. Ireland's Action for Jobs document (2016) placed FoodWise 2025 ambitions at the core of its roadmap to success, and it also formed the basis for national agri-food research calls^{iv}.

The broad objectives of FoodWise 2025 in terms of growth in agricultural output and exports appear on track to realisation. However, the overall assumptions for the plan made in 2016 are no longer fully valid in the situation facing the agri-food sector in 2020, which is much more complex. Some of the key external factors now affecting the sector are outlined below.

External Environment

Brexit poses many challenges for Ireland's agri-food sectors, particularly as agri-food exports are very dependent on the UK market. Future relationship negotiations between Europe and the UK must adequately address the key aims in the Political Declaration set out in late 2019, so as to avoid detrimental effects on Ireland's extensive agri-food trade with the UK^v. Due to their lower economies of scale, Irish SMEs are highly exposed to the UK departure from the EU.

The Paris Agreement on Climate Change in 2015 set out a framework and targets, designed to minimise increases in global average temperature to less than 2°C above pre-industrial levels; and to pursue efforts to limit the increase to 1.5°C^{vi}. In recent years, the apparent increase in the rate of global warming has put climate change at the top of the EU Commission agenda. In line with the Paris Agreement goals and guided by the EU climate and energy framework, Ireland has been set a target to reduce emissions by 20% and 30% in 2020 and 2030, respectively. The target for agriculture in Ireland is to reduce emissions by 10-15% by 2030, challenging the sector to make significant changes to its practices to reduce its emissions.

i <https://dbei.gov.ie/en/Publications/Research-Priority-Areas-2018-to-2023.html>

ii <https://dbei.gov.ie/en/What-We-Do/Innovation-Research-Development/Innovation-2020/>

iii <https://www.agriculture.gov.ie/foodwise2025/>

iv <https://dbei.gov.ie/en/Publications/Action-Plan-for-Jobs-2016.html>

v https://ec.europa.eu/commission/publications/revision-political-declaration_en

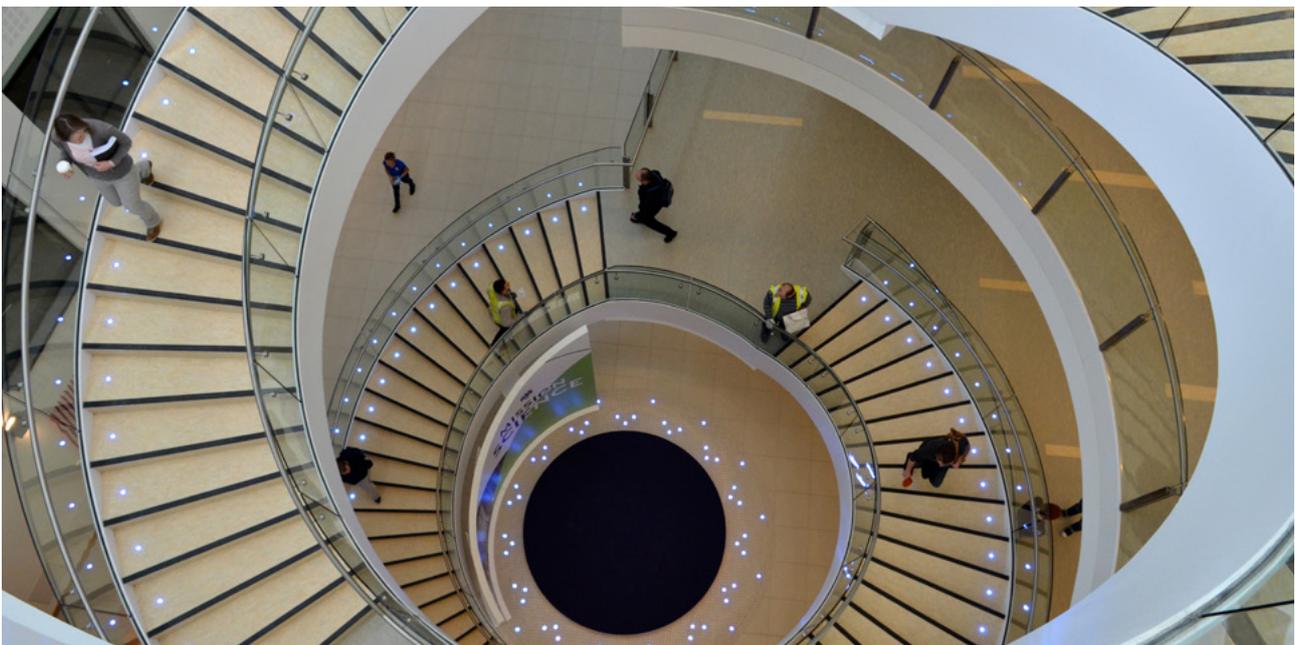
vi <https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement>

In September 2015, the United Nations adopted a Sustainable Development Agenda encompassing a set of global goals to end poverty, protect the planet, and ensure prosperity for all^{vii}. A list of 17 UN Sustainable Development Goals (SDGs) aims to address the most pressing challenges faced by the planet: the rising global population, mounting climate change, and food and nutrition security. Each goal has specific targets and sub-sets to be achieved by 2030, with 10 out of the 17 global SDGs directly linked to food and nutrition security.

Food 2030 is an EU research and innovation policy which aims to apply a holistic system-based principle to meeting the SDGs, and to future-proofing our food systems under four main priorities: Nutrition, Climate, Circularity, and Innovation^{viii}. This systemic approach views the way food is produced (and how it affects health, well-being and the environment) as a circular issue comprising all elements of food production, processing, packaging, logistics, and distribution, healthy people, and recovered waste streams.

In May 2020, the EU launched its Farm to Fork strategy outlining how all these aspects of the food chain will work together to create, in its words, a “favourable food environment that makes choosing a healthy and sustainable diet the easy choice”^{ix}. The strategy focuses on Healthy People, Healthy Societies and Healthy Planet, each of which will be framed and encapsulated by a sustainable food system.

The strategy is being launched amidst the backdrop of the COVID-19 crisis, which has amplified the importance of a robust and resilient food system and will undoubtedly raise new challenges such as food safety and immune health. As we learn to live with the virus, these and other factors such as climate change and food security will be central to discussions. This strategy will drive the research agenda over the next decade as it strives to make the targets it has set to transition the EU to a fair, healthy and environmentally friendly food system.



vii <https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

viii <https://op.europa.eu/en/publication-detail/-/publication/76d1b04c-aefa-11e7-837e-01aa75ed71a1> ix https://ec.europa.eu/food/farm2fork_en

ix https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en#Strategy



CHALLENGES AND TRENDS

CHALLENGES AND TRENDS

The Institute must work within the wider environmental, societal and technological framework and it must be cognisant of the challenges and opportunities that may arise that will impact on its research, and be agile to respond accordingly.

Climate Change & Natural Resources

Climate change is expected to have profound effects on our food system. Food production will be impacted due to reduced availability and quality of water coupled with ecosystem erosion through salination and acidification as a result of increased water levels. The yields of common crops, e.g. rice, maize and wheat, are expected to decrease and the poorest areas of the world will be worst affected. Warmer waters will have an impact on fisheries as viruses and other pathogens thrive in higher temperatures. Overall climate change will impact negatively on food security and steps are needed to develop a food-system responsive to climate change, which will mitigate against climate changes both now and in the future.

The food system has heavy demands on natural resources, many of which are not renewable. Implementing resource-efficient circular-economy principles across the whole food system, while reducing its environmental footprint, will be critical. Circularity will be required to ensure resource-efficient food systems and to minimise food waste.

Global Demographics

It is expected that by 2050 the population of the world will reach 10 billion, increasing the demand for food that will underpin a sustainable healthy diet for its citizens. As the demand for food grows, the demand for water for production and manufacturing will also increase. The expected increase in the proportion of the population in urban areas will reduce the number of farmers producing food, further challenging the sustainability of the food supply. In addition, to the population growth, it is estimated that by 2050, 22% of the global population will be over 65 years of age. Coupling this with an increased life-expectancy and a need for extended active working years, the need for nutritional solutions to both maintain and enhance the quality of life of this cohort becomes increasingly important.

Malnutrition

While the production of food is increasing across the world so is the hunger population due to the inequality of the distribution of food. As a result, in poor countries chronic undernutrition and poor-quality diets are endemic. Undernutrition in these countries occurs due to the lack of adequate calories. Paradoxically a scenario exists whereby adequate or excessive calories, but inadequate intake of essential nutrients, e.g. iron and vitamin A, is prevalent leading to overweight and obese populations in many developed countries. The numbers of people who are overweight and obese are increasing worldwide, and allied to this is an increase in cancer, cardiovascular disease and diabetes. It is estimated that by 2030, diseases related to diet and poor lifestyle will result in 67 million deaths per year. Further research is required to design cost-effective interventions to increase healthy dietary and lifestyle choices.

Digital Technologies & Innovations

Innovation is recognised as a key driver for long-term growth and sustainable development. The focus of innovation is not only on scientific and technological development of new products and processes, but also on organisational, behavioural and regulatory change, to address societal challenges and contribute to more sustainable development. A technological revolution is taking place in agriculture and food with the development of a wide range of innovations promising to substantially change the way we grow and distribute food.

The application of digital technologies has been transformative in the agri-food space. Enabling new and more efficient processes, digital technologies are expected to play an important role in overcoming many of the challenges facing the food industry, as well as helping consumers make informed decisions and adapt to healthy sustainable diets, ultimately future proofing our food systems.

Digitalisation may have impacts as follows:

- Machine learning and artificial intelligence to control food processing, leading to efficient and sustainable production processes;
- Blockchain technology to support transparency and efficiencies from farm production to the consumer;
- Application of the Internet of Things to improve logistics; use of smartphone applications to support consumers to live active healthy lives, and enable smart and personalised food choices, e.g. of the nutritional content/allergens in food;
- Building social platforms to connect SMEs to innovation hubs, to connect citizens to educational and social programmes, to create e-platforms to promote food safety;
- Building datahubs to support enhanced use and inter-operability of data across the food system, maximising use and impact.

Innovation has a key role to play in the growing bioeconomy, which is considered crucial to the sustainable growth of the agri-food sector and the European economy. Making the transition towards a circular, low carbon and resource-efficient bio-economy will require more research and innovation right across the agri-food sector in resource-efficient production and distribution systems, value-chains based on new and more efficient use of wastes (e.g. food waste), residues and by-products, as well as new business models that maintain and enhance natural capital.





VISION, MISSION AND VALUES

VISION

To be a global leader in the scientific discovery that shapes the future of food and health.

MISSION

To realise a world leading multi-disciplinary consortium engaged in pioneering research in food and health delivering:

- excellence in scientific discovery to promote diet-related health and wellness, in harmony with protecting the environment and the social and economic wellbeing of society;
- innovative outputs for industry to underpin competitiveness;
- research output to impact national and international policy and societal health;
- highly skilled researchers and postgraduate students networked with leading international institutes, with the skills to secure food systems for the future.

OVERALL GOALS

To future-proof global food systems enabling healthy living and societal well-being.

VALUES

In line with the UCD values, we will continually strive for excellence, operating with collegiality, creativity and to the highest level of integrity.

We will embrace equality, inclusion and diversity in all of our activities and ensure engagement with world leaders in the field to future-proof Irish and global food systems.



RESEARCH THEMES

RESEARCH THEMES

The Institute seeks to harness the expertise of its researchers and graduate students to future proof global food systems enabling healthy living and the well-being of society. To realise this ambition we will focus on five key research themes:

1. FOOD SAFETY

Securing food-safety throughout the food chain.

2. FOOD SUSTAINABILITY

Enabling the technological transformations to underpin environmentally, socially and economically sustainable food systems.

3. PRIMARY PRODUCTION SYSTEMS

Enhancing primary production systems to supply safe, nutritious, sustainable foods.

4. INNOVATIVE PROCESSING & FOOD QUALITY

Innovative processing to improve the safety, quality and sensory appeal of foods.

5. NUTRITION & HEALTH

Advancing nutrition research, to enable healthy living and well-being throughout the life course.



Consistent with the Food 2030 strategy and other policies, the Institute will take a “food systems” approach to its research. A Sustainable Food Systems approach is a holistic view of the food chain taking into account the activities of all the actors involved in the production, processing, distribution and consumption of food, while considering the implications of waste and disposal of food products and packaging during each stage. This approach recognises that the wider environment, political, economic and societal ecosystem in which the food system is embedded will influence these activities.

Fundamental to this approach is ensuring that how we produce our food into the future will have minimal impact on the environment and will ensure that we can produce enough food for the planet for the decades ahead. Factors that must be taken into account include the contribution of food production to climate change, water scarcity, soil degradation and the destruction of biodiversity. In doing so, the ultimate goal of the food systems approach is to ensure food and nutrition security on the planet, with healthy diets for all in society at the core of its activities. In this strategy we will address these elements of the Food System through the research themes outlined below.

1. FOOD SAFETY:

Securing food-safety throughout the food chain.

The aim of this theme is to develop new technologies to ensure the safety of the food chain and the protection of public health. The research will:

- a) Focus on Whole Genome Sequencing (WGS) to support public health decision making. The group will continue to build on its DNA sequencing platform to support on-going research and impact decision-making by the food industry. Linking with ongoing research, the objective is to create a National Digital Centre for WGS data and risk assessment, supported by a strong bioinformatics capability within the group.
- b) Advance the science of Antimicrobial Resistance (AMR). The evolution of AMR genotypes along the farm-to-fork continuum will continue to be supported. This work forms part of an extensive collaboration with many stakeholders including the China National Centre for Food Safety & Risk Assessment.
- c) Conduct risk assessment along the food chain using risk analysis to quantify the threats caused by food-borne hazards to human health, and to identify, assess and implement appropriate measures of intervention and control.
- d) Develop advanced modelling tools to investigate the impact of climate change on food safety, considering food as unsafe if it is injurious to health (due to pathogenic bacteria or mycotoxins) or unfit for human consumption (due to spoilage bacteria).
- e) Apply and further develop novel technologies that can rapidly identify, characterise and locate the microbiological risks in the food chain e.g. multi-scale and multi-spectral hyperspectral analysis. In addition, the research will focus on novel technologies that decontaminate without leaving residues and are not prone to microbial resistance e.g. cold plasma and light-based technologies.

2. FOOD SUSTAINABILITY:

Enabling the technological transformations to underpin environmentally, socially and economically sustainable food systems

The aim of this theme is to develop the theory, tools and practices to enable the technological transformation of Irish and European food systems to an environmentally, socially and economically sustainable system. It will seek to:

- a) Inform technology development through life cycle thinking.
- b) Shape policy through stakeholder engagement that considers consumers, industry and regulators through co-creation of knowledge.
- c) Realise sustainable production, processing and consumption.

The research will advance the scientific knowledge in the multiple disciplines involved in the sustainable production, processing and consumption of food. Sustainability thinking will be integrated as early as possible in the knowledge discovery and innovation cycle.

Social/consumer/business acceptance of sustainable food production, processing and consumption in Ireland and its trading partners will be addressed. Ultimately, the theme seeks to predict the impact of the possible futures of Irish food. The research team will draw on the expertise of: life cycle assessment; supply chain management; social impact assessment; policy landscaping and evaluation; environmental technology; business and economics.

3. PRIMARY PRODUCTION SYSTEMS:

Enhancing primary production systems to supply safe, nutritious, sustainable foods

The aim of the theme is to meet the challenge of increasing global food supply with greater resource use efficiency and preserve the diverse and natural ecosystems. There are three distinct areas in this theme that the research is focused on:

3.1 Develop Innovative Animal Production Systems

Research in this area will focus on sustainable, innovative animal production models, to improve animal welfare and address significant challenges faced by the Irish agri-food industry. The research will:

- a) Identify alternatives to antibiotics in livestock production and enhance gut health.
- b) Develop forage systems (e.g. multiswards) for sustainable ruminant production systems and improve efficiencies in grass-based production systems.
- c) Reduce greenhouse gas emissions and other negative environmental impacts.
- d) Enhance the health attributes of meat and milk products through precision animal nutrition.

3.2 Crop Improvement for Food Security

This research seeks to develop sustainable crop production systems to promote human health and ensure security of food and plant-derived materials. The research will:

- a) Develop superior small grain crops through genomic prediction and selection of the best cultivars adapted to the Irish environment.
- b) Use precision agriculture to improve crop production and resilience, focusing on the improvement of phenomics tools to integrate in time and space the performance of the crop in terms of capturing resources (e.g. radiation, water, nutrients) and how efficiently these resources are used.
- c) Focus on reducing intensive pesticide use by providing strategies to control major cereal diseases by identifying genetic disease resistance, developing novel biocontrol methods as well as understanding and monitoring pathogen virulence in the field.

3.3) Smart Agri Technologies

This research seeks to facilitate the development of machine learning systems and decision support tools to assess and improve crop production. The research will draw on a wide-range of data-capturing technologies e.g. machinery telemetry, proximal and remote sensing, input applications, yield mapping, weather monitoring, multi and hyperspectral imagery, pest and disease pressures, and Farm Management Systems software. This data is leveraged to capture, measure, and influence crop variabilities with the goal of optimising returns on input investment while conserving valuable resources.

4. INNOVATIVE PROCESSING & FOOD QUALITY:

Innovative processing to improve food safety, quality and sensory appeal to consumers

Innovations in sourcing, processing and delivery of foods and food ingredients have strong potential to offer a wide range of benefits to the agri-food industry, consumers, and society in general. This theme aims to successfully exploit these innovations to deliver foods with improved taste, texture and health attributes with reduced costs and environmental impact. It will focus on three areas seeking to:

4.1) Develop Innovative Processing Technologies

The research will focus on the development of alternative approaches that use gentle processing regimes to retain key organoleptic properties; that convert food waste into bio-based products (and other zero-waste processing); and that validate improved models to predict the effects of new processing methods on the retention and transformation of nutrients, the bioavailability of micronutrients and macronutrients, and physiological effects.

4.2) Develop Process Analytical Technology – Sensors

Industry 4.0 denotes the concept of a manufacturing system with full integration of cyber and physical technologies, wherein machines and devices communicate with each other, as well as with users. To facilitate industry adoption of Industry 4.0, our research will focus on developing versatile and affordable sensors to be applied for the quantitative, real-time, on-line or in-line control of critical quality and performance attributes for raw and in-process materials during food processing in the context of Process Analytical Technology.

4.3) Design New Food Structures

Enhanced functionality of food in terms of taste and nutrition may be achieved by innovations in the assembly of food ingredients into a food matrix through synergistic effects between ingredients and processes. Our research will focus on understanding structure-function relationships that allow for the design of food structures to enhance the bioavailability of macro and micronutrients and sensory characteristics.

5. NUTRITION & HEALTH:

Advancing nutrition research, to enable healthy living and promote wellbeing throughout the life course

The aim of this theme is to advance nutrition research to enable people to live healthy lives and promote well-being through the life course. This will be achieved through research across all aspects of nutrition from molecular to public health. The research will focus on four areas, each of which will provide the evidence for positive outcomes on public health:

5.1 Biomarker Research

Within this area the group's research looks at the acute assessment of dietary intake through the use of novel biomarkers, working to establish new biomarkers of long-term dietary exposure. It also aims to identify new or novel biomarkers of health.

5.2 Lifecourse Studies

The group examines the impact of diet and lifestyle factors on disease risk across the life-course and generations. It also is active in the collation, analysis and interrogation of data arising from the national food consumption surveys across the life course.

5.3. Personalised Nutrition

Work in Personalised Nutrition or Precision Nutrition revolves around developing strategies for the delivery of dietary advice at a personal level. Other aspects of interest within the group include the development of new food bioactives for improvement of health such as glycaemic management, lipid metabolism and inflammation.

5.4. Healthy Ageing

Working closely with colleagues in the Processing theme, the group is looking at nutrition intervention strategies to promote healthy ageing, whilst targeting malnutrition in older populations.



GOALS & ENABLERS

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To deliver on our overarching goal to **Future Proof Global Food Systems** enabling healthy living and societal well-being, the Institute has three goals:

Goal 1: Increase the quality and quantity of our research and innovation in sustainable food and health consistent with our areas of research excellence.

Goal 2: Deepen and expand our partnerships and collaborations with leading research institutions, the agri-food commercial sector and regulatory bodies.

Goal 3: Demonstrate global leadership by communicating and translating our research to impact positively on society.

Enablers

To realise our goals, three critical enablers are required:

- 1. Attracting highly skilled academic staff, researchers and students:** Academic staff (faculty) and students are central to how we work and to realising our goals. We are committed to enabling the recruitment of the top faculty, researchers and students in the area of food and health to UCD. We will continue to support and develop our Institute members and their research teams, delivering the next generation of highly skilled leaders for the agri-food sector and its allied industries and services.
- 2. Supporting our members to compete successfully for research income:** Research income – and in particular non-exchequer funding – is required to ensure that we can continue our research and deliver on our strategy. We will support our members to identify and secure funding to support their research activities.
- 3. Building a highly networked research ecosystem with access to world-class infrastructure and facilities:** Infrastructure and facilities to support and house our research teams are critical. We will support our members in identifying funding opportunities for new and replacement equipment and large-scale infrastructure. We will lobby as necessary for financial support outside those traditional sources. Some of this equipment will require technical assistance and we will liaise with relevant schools in discussions on how we can help in acquiring this support.

DELIVERABLES AND KEY PERFORMANCE OBJECTIVES 2020 - 2024

GOALS	OBJECTIVE <i>We will...</i>	OUTPUT <i>In order to...</i>
1: Increase the quality and quantity of our research and innovation in sustainable food and health consistent with our areas of research excellence	<ul style="list-style-type: none"> • Create a supportive environment to enable researchers to pursue their research ambitions. • Develop a collaborative community of researchers within the Institute, leveraging and connecting a range of disciplines. • Provide support to compete successfully for funding from both exchequer and non-exchequer sources. 	<ul style="list-style-type: none"> • Maximise the excellence and impact of our members' research. • Develop a new generation of highly skilled research leaders in food and health. • Secure income to support excellence in research. • Create innovative solutions for the global challenges facing food and health activities.
2: Deepen and expand our partnerships and collaborations with leading research institutions, the agri-food commercial sector and regulatory bodies	<ul style="list-style-type: none"> • Deepen existing relationships and explore new partnerships with leading research institutions. • Continue to support our relationships with funding agencies, policymakers and regulatory bodies. • Develop systems to enhance interaction with industry, including the provision of additional services, both educational and technical. 	<ul style="list-style-type: none"> • Add value to our activities and partner with the leading experts worldwide. • Ensure our members' research continues to be funded and to have a positive impact on health, society and the economy. • Keep the agri-food sector abreast of cutting-edge research and ensure our ability to support the safety and sustainability of the agri-food sector.
3: Demonstrate global leadership by communicating and translating our research to impact positively on society both nationally and internationally	<ul style="list-style-type: none"> • Develop a comprehensive communications programme. • Support our researchers to communicate their research. 	<ul style="list-style-type: none"> • Raise the profile of the Institute and UCD as a global leader in food and health. • Inform policy from debate to implementation. • Enable the Institute to translate food and health research to impact the environmental, social and economic wellbeing of society.

KEY PERFORMANCE INDICATORS

KPI 1	Increase our publication output by 2% on a yearly basis and maintain the citation impact at 2.2.
KPI 2	Funding increased by 10% on a year on year basis with a target of 40% of total funding coming from non-exchequer funds.
KPI 3	Increase the proportion of publications with our international partners to 60% of our total publications.
KPI 4	Support the hosting of at least one major annual international conference and policy workshop.

IMPLEMENTATION

We cannot achieve all our ambitions simultaneously. This is why an implementation plan will be drawn up annually, in which we will identify a number of priority areas that will receive additional attention during that year. In these implementation plans, the objectives will be described in greater detail than in the present plan. We will appoint leaders in priority areas and closely monitor progress throughout the year.

This strategy is being launched in a very dynamic period as we come close to the timeline when Brexit will be implemented, and we endeavor to cope with the ongoing COVID-19 pandemic. Naturally, we will continue to monitor our internal and external environments so that if necessary, we can adapt our strategy as is required. We will continue to work collectively drawing on the expertise across the breadth of UCD and partnering with international leaders and stakeholders to address new challenges as they arise.



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FUTURE-PROOFING GLOBAL FOOD SYSTEMS