Australian Academy of Science

NATIONAL COMMITTEE FOR NUTRITION | AUSTRALIAN ACADEMY OF SCIENCE | JULY 2019

NOURISHING AUSTRALIA

A decadal plan for the science of nutrition

Realising health, environmental and economic opportunities to benefit all Australians

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ACKNOWLEDGEMENTS

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We would like to extend our sincere gratitude also to the participants of the 2017 Theo Murphy High Flyers Think Tank, who undertook the initial scoping that informed this decadal plan. We would also like to thank the members of the nutrition science community who contributed to this plan, whether that be by hosting or attending a consultation workshop, providing input on the draft plan or by contributing photos to help this plan truly reflect Australian nutrition science.

We would also like to acknowledge the work of Academy secretariat staff Dr Hayley Teasdale, Dr Alistair Usher and Dr Chris Hatherly for managing and overseeing this project.

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DISCLOSURES OF INTEREST

Disclosures of interest from members of the Expert Working Group for 2014 to 2019 are listed below.

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Grants: National Health and Medical Research Council, JDRF International, Diabetes Australia, JDRF Australian Type 1 Diabetes Clinical Research Network, Novo Nordisk, Australian and New Zealand Society of Nephrology

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Grants: Australian Research Council, Horticulture Innovation Australia, Pork Cooperative Research Centre, Innovation Connections. Supporting partnership contributions as a component of grants received from: Arcadia Biosciences, Ardent Mills, Arnott's, Australian Vinegar, Manildra Group, PepsiCo, SunRice

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Grants: Australian Research Council, National Health and Medical Research Council, Novo Nordisk Foundation, Canadian Institutes of Health Research, Agence Nationale de la Recherche (France), Biotechnology and Biological Sciences Research Council (UK). Supporting partnership contributions as a component of Australian Research Council Linkage grants received from: Sanitarium, Australian Plague Locust Commission, Taronga Conservation Society

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Professional memberships: Dietitians Association of Australia (Advanced Accrediting Practicing Dietitian), Nutrition Society of Australia, British Dietetic Association, American Society of Nutrition, Fellow of the Association for Nutrition

CONSULTATION

The decadal plan Expert Working Group committed to taking a consultative approach in preparing this plan. It engaged with a broad cross section of the nutrition community to develop the plan and to seek feedback and input. The committee held a number of targeted meetings, attended professional society functions and university-based open forums and interviewed key decision-makers.

The process for plan development involved:

- initiation
- consultation paper development
- sectoral consultation
- draft plan development
- finalisation of the decadal plan
- publication, launch and the beginning of implementation.

The first event in support of the decadal plan was the 2017 Theo Murphy High Flyers Think Tank 'Rethinking food and nutrition science: Aspirations, obstacles and strategies for the future'. More information on this meeting may be found at www.science.org.au/news-and-events/events/think-tanks/rethinking-food-and-nutrition-science

National community consultation meetings:

- Canberra, 20 June 2018
- Melbourne, 28 June 2018
- Wollongong, 4 July 2018
- Adelaide, 9 July 2018
- Sydney, 16 July 2018
- Newcastle, 26 July 2018
- Brisbane, 2 August 2018
- Perth, 9 August 2018
- Hobart, 15 August 2018
- Launceston, 15 August 2018
- Webinar, 20 August 2018
- Melbourne, 3 September 2018

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FOREWORD

This decadal plan, Nourishing Australia, presents a bold plan for the science of nutrition in Australia; a plan to harness our world-class scientific knowledge to help combat one of the most significant challenges humanity will face in the coming decade: the double burden of malnutrition and obesity.

This decadal plan is an important example of the power that the National Committees for Science, convened by the Australian Academy of Science, can have in bringing many different people together from across a scientific discipline. These committees are uniquely placed to bring together societies, research institutions or industry groups with similar aspirations and provide an impartial platform to create cohesive strategies for their scientific discipline. The National Committee for Nutrition led the development of Nourishing Australia, and I commend them on delivering a plan that represents such a diverse community in a way that truly embodies how varied—yet interconnected—the nutrition science community is in Australia.

It is evident from this plan just how many disciplines will need to work together to secure our nutrition and food future. The writing and consultation process alone initiated many important conversations that will pave the way towards creating innovative solutions for the future of Australia and our region.

Over the next ten years, radical action is required to ensure Australia's food and nutrition security, improve our health and wellbeing and reduce our impact on the environment. Nourishing Australia outlines steps that need to be taken to secure our future. This plan was written by the community, and so must the community carry the recommendations forward and take action towards realising their vision. This will be no small feat, but we have never been better equipped to meet these challenges.

Dr TJ Higgins AO FAA FTSE
Vice President and Secretary for Biological Sciences (2015–2019)
Australian Academy of Science

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Fundamental changes in the way that food is produced, distributed and consumed during the past two centuries have been instrumental in allowing us to feed an expanding global population in the face of increasing land and natural resource constraints. Recently, the world has seen a dramatic increase in the scope of nutritional challenges, with around two billion people affected either by undernutrition and nutritional insecurity or by diseases of overnutrition, including obesity and its many associated comorbidities.

Nutrition is a primary mediator between our biology and our physical and mental health, and has enormous potential for the prevention, management and treatment of human disease. Achieving that potential requires a profound shift in understanding, approach and practice—a revitalised science of nutrition that:

- integrates with research fields that focus on the societal and economic factors that shape our food environment and influence dietary behaviour
- moves away from emphasising the roles of single nutrients or commodities and better integrates knowledge across nutrients, foods and dietary patterns to understand how diet impacts health and disease
- goes beyond observational association to establish the biological, behavioural and societal mechanisms through which nutrition impacts health and disease processes
- engages a diversity of disciplines to identify system leverage points, intervention and evaluation strategies, and to model the system-wide impacts of nutrition, sufficient to tailor and optimise a sustainable and healthy food production, supply and consumption to achieve local, national and international health, societal, environmental and economic goals
- reflects its capacity to inform and integrate across the many realms and disciplines that are fundamentally impacted by nutrition by supporting nutrition literacy in the community and developing health professional research and education.

These targets are now tractable due to recent advances in nutrition theory, the integration of psychology, social sciences and economics to define societal and commercial influences, and rapid progress in molecular and systems biology. These and other approaches are greatly facilitated by the ability to obtain massive experimental datasets, such as those from multiple omics technologies, citizen science and prospective cohort studies, and the computational power to systematise and analyse these data. When combined with established approaches in epidemiology, intervention trials and basic mechanism of action studies, many of the key biological science challenges in nutrition can now realistically be tackled. However, in order to achieve lasting impact and population health benefits, greater focus on social and environmental factors will be necessary. Indeed, without a strengthened contribution from the broad range of social, economic and environmental disciplines to the science of nutrition, traditional approaches will not deliver their potential benefits in translating knowledge into impact.

Australia enjoys a global reputation for its nutrition science, one of many disciplines where we 'punch above our weight'. In combination with established strengths in our agrifood industry, medical technology, social sciences and higher education sectors, Australia is entering an era of opportunity to be a regional and global leader in broadening the science of nutrition and linking it to health, social, environmental and economic outcomes for the benefit of all Australians.

Professor Mike Gidley
Chair, National Committee for Nutrition
Co-chair, Decadal Plan Expert Working Group

Professor Stephen Simpson AC FAA FRS
Co-chair, Decadal Plan Expert Working Group

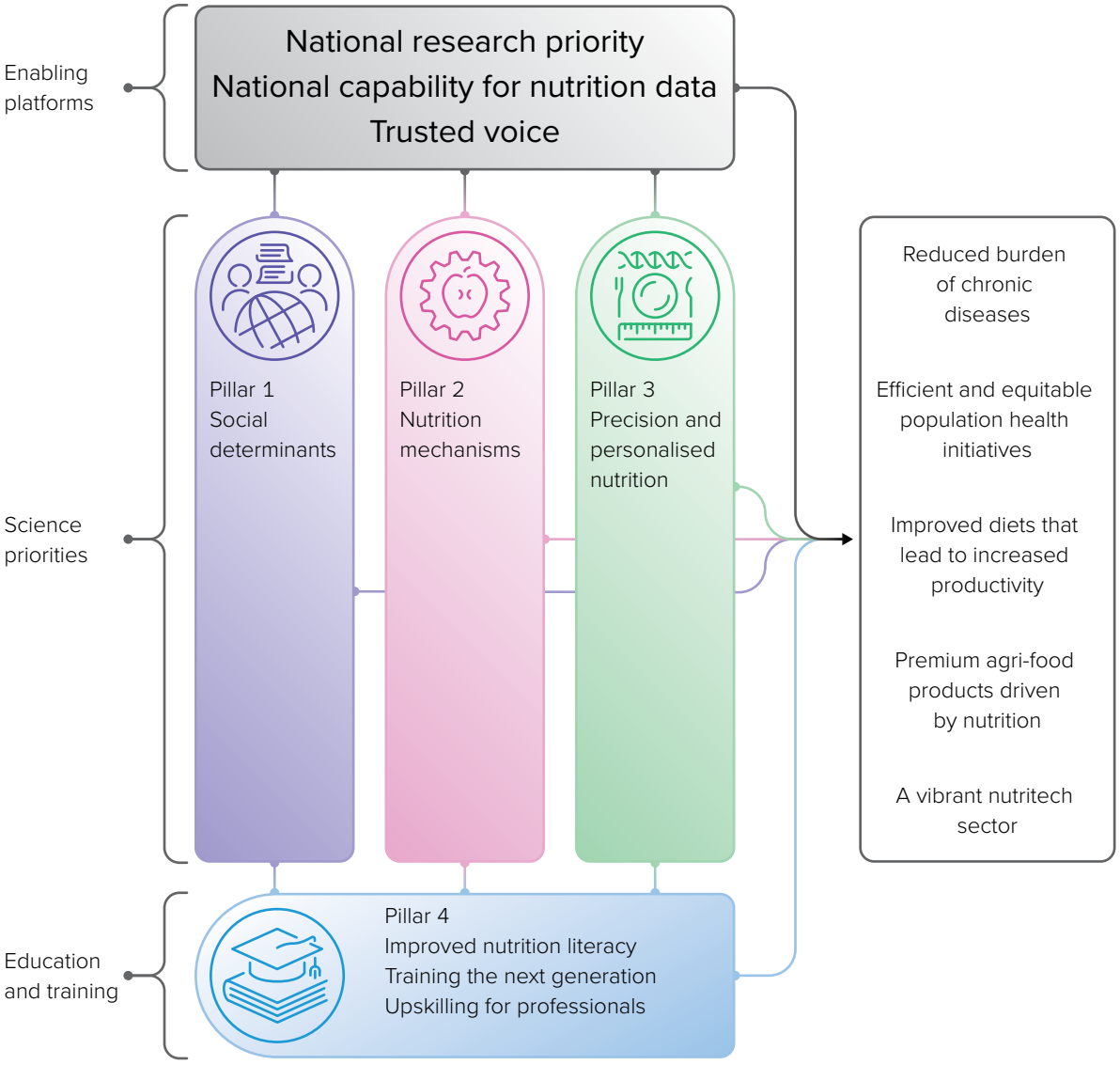
CREDIT: SHAUN COWARD / UNSPLASH / PUBLIC DOMAIN

EXECUTIVE SUMMARY

The science of nutrition is entering an exciting era, with recent advances in measurement technologies, policy insights and complex data analysis, coupled with new theory frameworks that offer a promise of tackling many complex scientific and pressing societal challenges in which food and nutrition play a central role. This decadal plan sets out a strategy for realising the vision that **Australian nutrition science plays a key role in improving long-term health and wellbeing globally, while delivering environmental, social and economic benefits nationally** with core values of *equity*, *sustainability*, *collaboration* and *innovation*.

The plan is aspirational and further consultation is needed prior to implementation. Successful implementation is expected to result in health, wellbeing and economic benefits, including:

- reduced burden of chronic diseases from increased nutrition literacy, and greater understanding of cause-and-effect mechanisms linking dietary patterns to health and disease
- cost-effective, equitable population health initiatives developed from accurate knowledge of current diet–health relationships and addressing societal and commercial factors
- improved diets leading to increased physical and mental health
- nutrition credentials that will drive a premium agrifood sector, particularly for exports
- growth of a 'nutritech' sector that provides software, hardware, analysis and commercial services to support a healthy and sustainable food and health system
- helping to achieve global targets such as the UN Sustainable Development Goals.



PLATFORMS

To achieve these benefits and more, three enabling platforms are required:

1 NUTRITION AS A NATIONAL RESEARCH PRIORITY
to address technical, social and environmental challenges through multidisciplinary collaboration and innovation, resulting in major health and economic benefits.

2 A NATIONAL CAPABILITY FOR NUTRITION DATA
to capture and analyse dietary intake and health outcomes of Australians to guide national policy and intervention strategies and stimulate the science of nutrition.

3 A 'TRUSTED VOICE'
to provide credible, evidence-based nutrition information and use professional communicators to counteract misinformation and improve general society nutrition literacy.

PILLARS

These platforms support and are supported by four pillars:

1 SOCIETAL DETERMINANTS
Understanding how food environments drive dietary patterns and identifying intervention strategies for improved outcomes.

2 NUTRITION MECHANISMS
Identifying cause-and-effect relationships between diet and health or disease.

3 PRECISION AND PERSONALISED NUTRITION
Improving cost-effectiveness through targeted dietary solutions.

4 EDUCATION AND RESEARCH TRAINING
Enhancing the population's food and nutrition literacy and growing the professionalisation of specialised nutritionists.

VISION

AUSTRALIAN NUTRITION SCIENCE PLAYS A KEY ROLE IN IMPROVING LONG-TERM HEALTH AND WELLBEING GLOBALLY, WHILE DELIVERING ENVIRONMENTAL, SOCIAL AND ECONOMIC BENEFITS NATIONALLY.

The way forward includes developing detailed governance structures and business cases for the establishment and sustainable resourcing of the national nutrition data capability and trusted voice, scoping major initiatives consistent with a national research priority and providing a forum for the development of national collaborations across the broad scope of the science of nutrition.

VALUES

1 EQUITY
Ensuring that advances in the science and application of nutrition benefit all Australians and regional partners.

2 SUSTAINABILITY
Delivering long-term benefits through continuous monitoring and communication of diet–health relationships, training the next generation of nutrition scientists and integrating environmental sustainability into nutrition knowledge.

3 COLLABORATION
Embedding a culture of shared resources and responsibilities to realise the benefits of integrated, cross-disciplinary approaches.

4 INNOVATION
Embracing the opportunities of new science and complex and diverse data to drive community, public and private sector opportunities for the betterment of health and productivity of Australians.

By using these values to deliver real impacts, the vision will be realised through a focus on four priority pillars:

PILLAR 1
SOCIETAL DETERMINANTS

- Developing a framework for the food system that supports equitable access to healthy foods and effective population nutrition interventions, underpinned by national policy development
- Combining quantitative and qualitative research to assess the drivers of dietary choices and the social context within which they are made
- Quantitatively mapping Australia's food and nutrient intake and health (biomarkers) to identify intervention opportunities, leading to:
  - cost-effective use of resources and increased impact of nutrition messages, programs and policies
  - assessment and monitoring of food environments and contributory factors.

PILLAR 2
NUTRITION MECHANISMS

- Identifying mechanisms by which diets, foods and nutrients influence human biology
- Defining how and why dietary patterns affect health and wellbeing outcomes, leading to:
  - enhanced population dietary advice
  - targets for high-value agrifood.

PILLAR 3
PRECISION AND PERSONALISED NUTRITION

- Understanding group and individual differences in responses to dietary patterns and their interactions with prescribed medications
- Developing data analytics from measurement of nutritional status, health status, age and genotype and envirotype sufficient to predict solutions for diet and lifestyle change, leading to:
  - precision and personalised diet and lifestyle advice with cost-effective health benefits
  - nutritech start-up opportunities aimed at fostering innovation through developing new tools, products, programs and services to deliver better health outcomes.

PILLAR 4
EDUCATION AND RESEARCH TRAINING

- Supporting a future workforce in the science of nutrition via competency-based education that incorporates genomics, bioinformatics and systems biology, both in formal nutrition education as well as incorporating nutrition into medical and allied health professional training and development
- Developing and sustaining skilled professionals to research, innovate, communicate, counsel, train and educate, leading to:
  - a nutrition literate and well-informed general populace, able to make effective choices around diet and nutrition
  - capacity building for Australia and the region, coupled with higher education capability growth
- Developing capacity of the nutrition workforce, supported by a network of nutrition leaders who are skilled in complex and adaptive thinking with foresight and broad vision, who work collaboratively across disciplines and sectors to positively influence food systems and nutrition.

The science of nutrition is entering a new era of opportunity

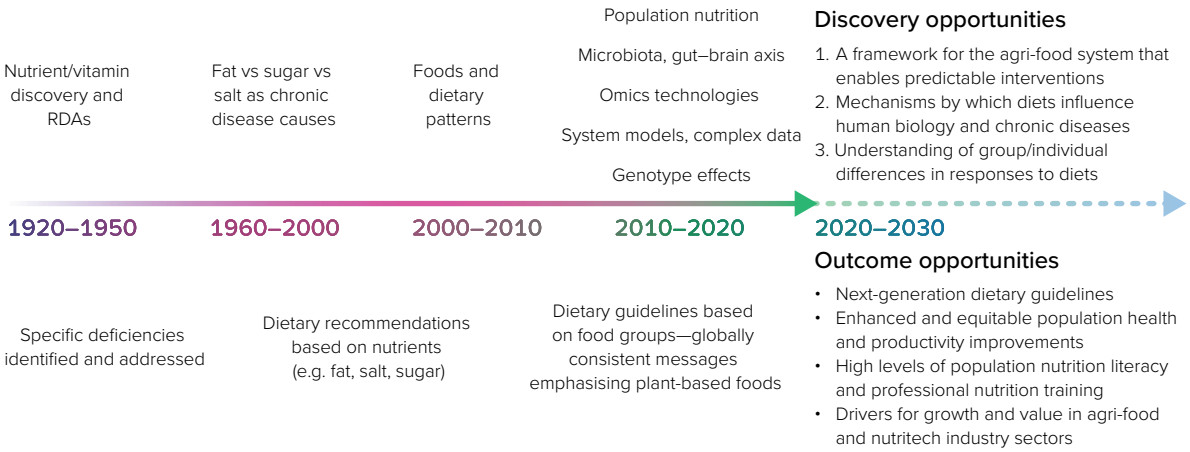
The science of nutrition has evolved significantly over the past hundred years. The focus has shifted from identifying specific essential nutrient requirements to avoid deficiency diseases (for example, vitamins and minerals), through the roles and potential health challenges posed by specific food components (particularly saturated and trans fat, alcohol, added sugar and salt), to the current global consensus that dietary patterns are the most appropriate guide to health outcomes and the need to understand the *interactions* among foods and nutrients on health, rather than focusing on single components. The move from a reductionist focus on specific nutrients to a whole-of-diet approach represents a major dislocation that public policy, consumer understanding and the food industries are yet to come to terms with. In parallel, a growing understanding of the role of societal and commercial factors in determining food intake, food choice behaviour and subsequent health outcomes is leading to a reappraisal of approaches to tackle inequalities in nutrition security.

The science of nutrition will play a strong role in the next decade by:

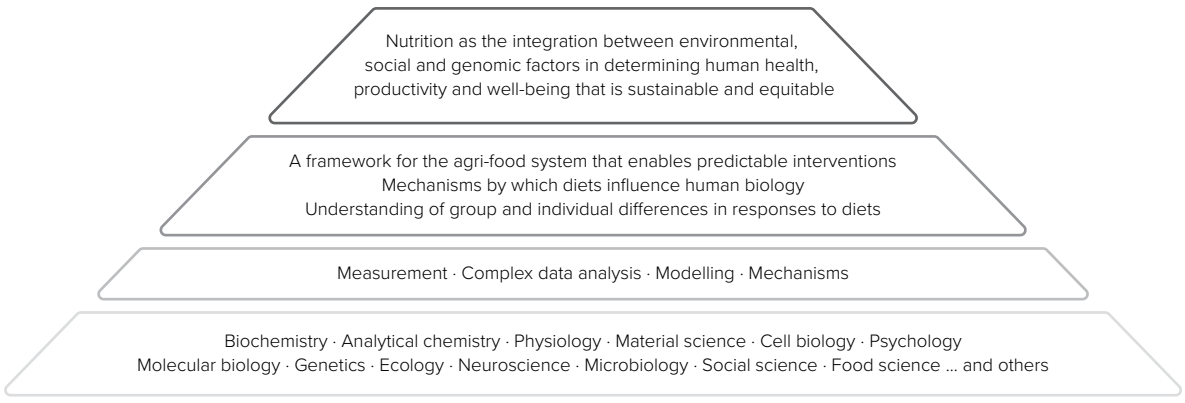
- identifying how population dietary interventions with greater chances of success than current approaches can be made through identifying and managing societal and commercial factors (pillar 1)
- providing understanding of the mechanisms by which dietary patterns, as well as specific foods and nutrients within them, influence human biology (pillar 2)
- defining how group and individual differences in genotype, age and environment influence nutritional and health outcomes (pillar 3)
- developing the profession of nutrition through competency-based education and communicating with consumers via consistent and trusted messaging (pillar 4).

The modern science of nutrition integrates concepts, theories and approaches from a diverse range of disciplines, including social, agricultural, biological, medical, physicochemical and environmental sciences. This diversity reflects the pervasive and system-wide influence of nutrition. Enabled by major recent capability advances in measurement, modelling and complex data analysis, the science of nutrition provides a timely grand challenge to integrate concepts across disciplines to derive mechanisms that will inform new approaches to enhancing human health, productivity and wellbeing.

The era of opportunity for the science of nutrition



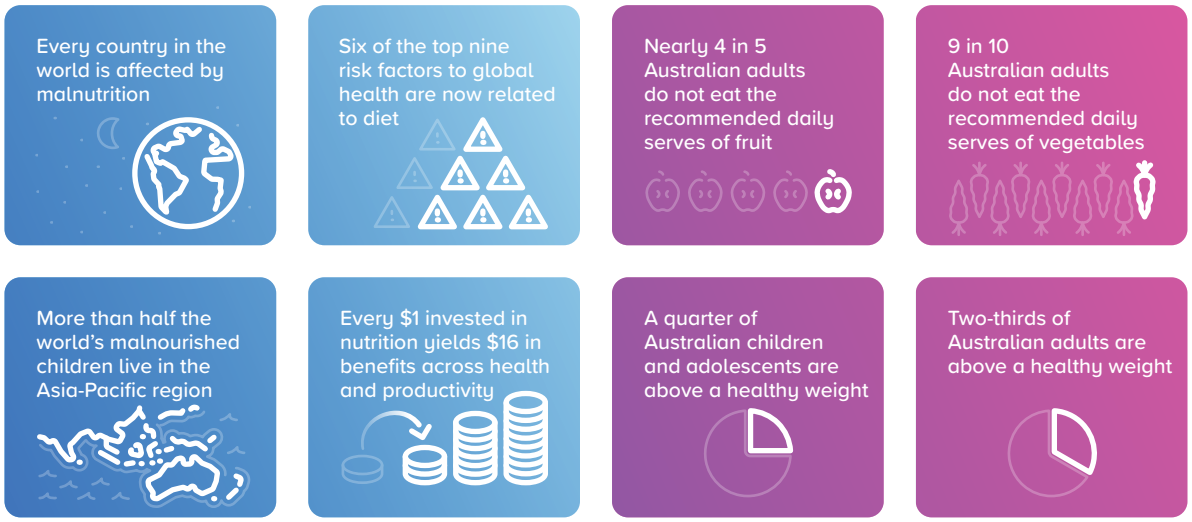
Driving the science of nutrition through integration across disciplines



SITUATIONAL SNAPSHOT

The Merriam-Webster dictionary defines nutrition as 'the act or process of nourishing or being nourished'. For any organism, including humans, the benefit of good nourishment is the ability to not just survive, but thrive in their environment.

The benefits of human nutrition extend across the whole lifespan and are a central determinant of not only health outcomes, but also quality of life and mental and physical productivity. Optimising nutrition can reduce the burden of malnutrition and stimulate workplace and economic productivity.



Statistics obtained from the *2018 Global Nutrition Report*

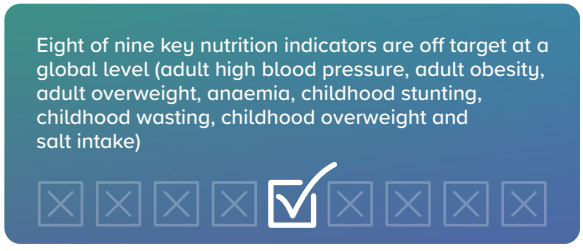
Statistics obtained from 2018 AIHW report *Nutrition across the life stages*

The *2018 Global Nutrition Report* tracks the progress of countries against nine nutrition targets:

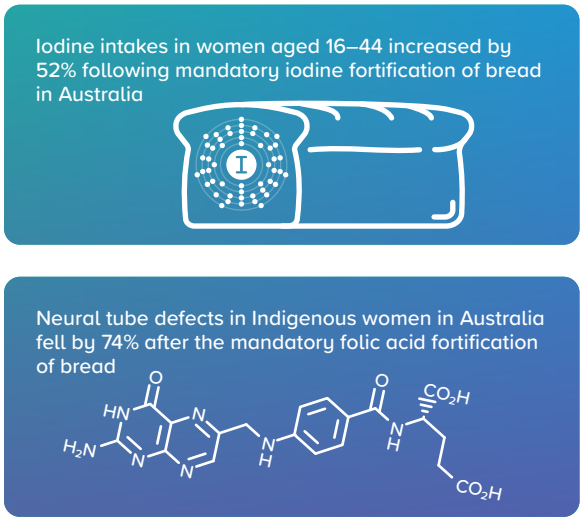
1. child overweight
2. child wasting
3. child stunting
4. exclusive breastfeeding
5. diabetes among women
6. diabetes among men
7. anaemia in women of reproductive age
8. obesity among women
9. obesity among men.

Despite being a wealthy country with high agricultural productivity and food quality, Australia is listed as being on track to achieving just two of the nine nutrition targets. In part, this is because of inequalities in wealth distribution that result in many people finding it difficult to afford a healthy diet, particularly in rural and remote areas where fresh food is more expensive. The importance of supporting production of good quality and healthy agricultural products, and ensuring it is accessible, affordable, sustainable and healthy for all Australians, including the most vulnerable, requires acknowledgement reflected in commitment to a broad range of nutrition-related actions.

With the limited land, water, energy and nutrient resources available to feed a population of up to 10 billion people, it is a reality that sustainability of global resources is intimately connected to current and future food and nutrition security. This adds further complexity and importance to identifying and achieving appropriate dietary patterns across populations into the future. Producing more of the same food in the same way will not suffice. Sustainable diets that maximise nutritional outcomes require that we rethink current production and commercial practices, manage resources and the food system responsibly and facilitate and support changes in dietary behaviours.



Statistics obtained from the *2018 Global Nutrition Report*



Examples of how nutrition science has informed policy and led to improved health outcomes (statistics obtained from AIHW report *Monitoring the health impacts of mandatory folic acid and iodine fortification 2016*)

The Australian Blood lime is one in a range of hybrid limes developed by CSIRO Plant Industry for commercial cultivation. It is a hybrid produced by open pollination, from a cross between an Ellendale mandarin (a mandarin and orange hybrid) and a seedling form of the Australian finger lime (*Citrus australasica* var. *sanguinea*).

NUTRITION SCIENCE GLOBALLY, NATIONALLY, LOCALLY

The challenges of persistent malnutrition and diet-related chronic diseases are both global and local. Australia has continuing and pressing issues in nutrition insecurity, particularly in disadvantaged and remote communities, as well as well-documented challenges in addressing rising rates of obesity, diabetes and other diet-related chronic conditions.

Australia has an interest in ensuring these challenges are addressed. While the Australian science community contributes strongly to the global effort, it has done so in the absence of regular monitoring of diet and health relationships within Australia itself. National nutrition surveys are infrequent and irregular, resulting in a lack of current information on the relationship between food intake and health outcomes for Australians. Neither have we assessed, benchmarked and monitored the food environments, determinant factors (including conventional, social and electronic media and marketing) and government policies for nutrition impacts, or the perceptions, beliefs and motivations around diet in Australians. These deficiencies urgently need to be rectified. Mobile and web-based surveys and linkage with complex datasets make this a much easier prospect than in the past, allowing for ongoing detailed data collection and analysis that can inform national and local policy and action.

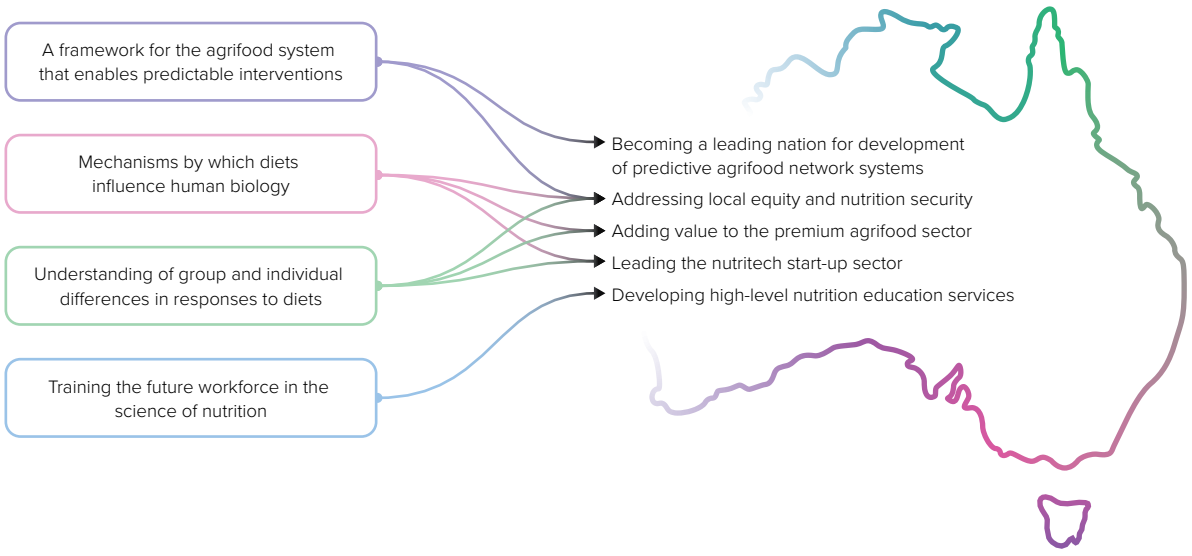
A constraint on advancing the science of nutrition in Australia is that there is currently no national nutrition policy or plan. A policy or plan based on robust evidence that reflects the four pillars of this plan would provide a framework for sustainable population health improvement initiatives.

Australia, with its climatic, geographical and demographic diversity and modest population, has an opportunity to play a key global role as a model for developing a holistic understanding of the complex agrifood system and the consequences for food intake and nutrition and resulting health prospects (pillar 1).

Improved nutrition security and health of Australians through each of the pillars is the major driver for this plan, but the science of nutrition can also significantly contribute to important sectors of the Australian economy. These include:

- an agrifood sector that produces all components of a healthy dietary pattern and positions Australia as a preferred country of origin for key export destinations. Understanding the underlying mechanisms of the health benefits of (combinations of) Australian foods supports the marketing needed to grow exports of premium foods and meals. Current challenges such as reciprocal influences between diet and climate change, and opportunities such as gene editing and other new methods, should be assessed in the context of enhancing potential health value from agriculture (pillar 2)
- a fast-growing nutritech sector that offers services and measurement technologies to assist professionals and the community in relating nutritional requirements to dietary solutions. This is relevant in precision and personalised nutrition applications for either cost-effective health outcomes or enhanced performance through dietary pattern adjustment (pillar 3)
- a higher education sector that is well placed to provide professional training and career development in the science and application of nutrition for domestic and international students (pillar 4).

Australia's opportunities



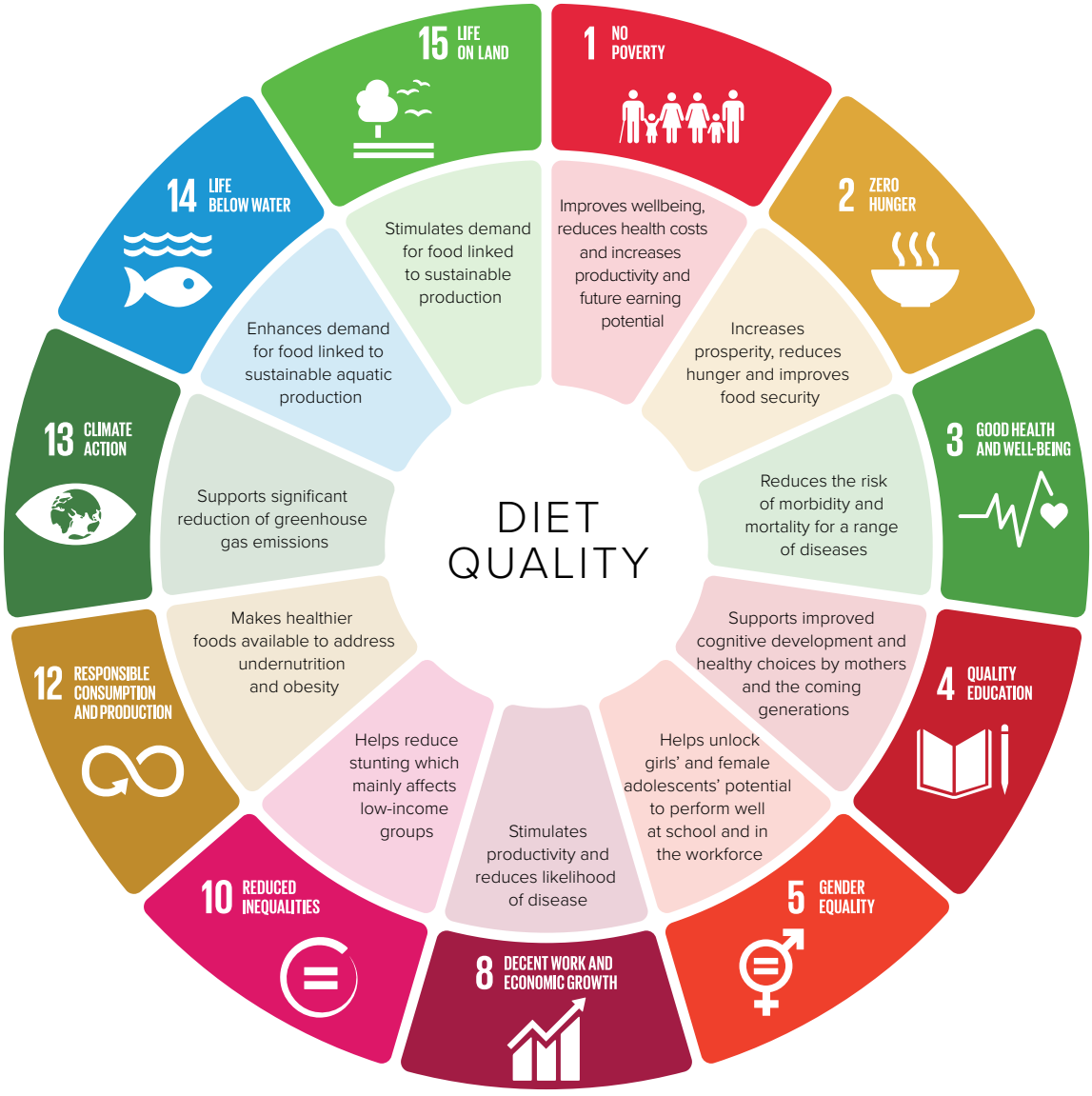
Professor Martina Doblin (UTS) leads the Productive Coasts research program within the Climate Change Cluster (C3) in the UTS Faculty of Science. Her work contributes to solving Australia's grand challenges of food security, biodiversity conservation and ecosystem health, as well as climate variability and change.
CREDIT: ANDY ROBERTS ©

NUTRITION SCIENCE AND THE SUSTAINABLE DEVELOPMENT GOALS

The Sustainable Development Goals (SDGs) form part of the 2030 Agenda for Sustainable Development set by the United Nations in 2016. The science of nutrition informs high-quality diets and sustainable agriculture. The interactions between societal factors, food availabilities, dietary practices and nutrition outcomes are crucial in achieving the SDGs.

The goal most directly linked to nutritional outcomes and this decadal plan is SDG 2: to end hunger, achieve food security and improved nutrition and promote sustainable agriculture. These aims integrate and link food security, nutrition and a sustainable and climate-resilient agriculture. Nutritional outcomes and the science of nutrition also have particularly strong interactions with another 10 goals, placing the discipline at the heart of the global drive for sustainable development. As a central element of achieving the SDGs, actions in all areas need to incorporate consideration of impacts on, and achievement of, healthy and sustainable diets.

The SDGs present an opportunity to integrate approaches and interventions to improve nutrition and will be important for ensuring equity among the population with the evolution of the science of nutrition. The path to achieving global targets for nutrition allows opportunities to advance multiple SDGs simultaneously, likewise broad investments in education, climate change or water will influence nutrition outcomes.



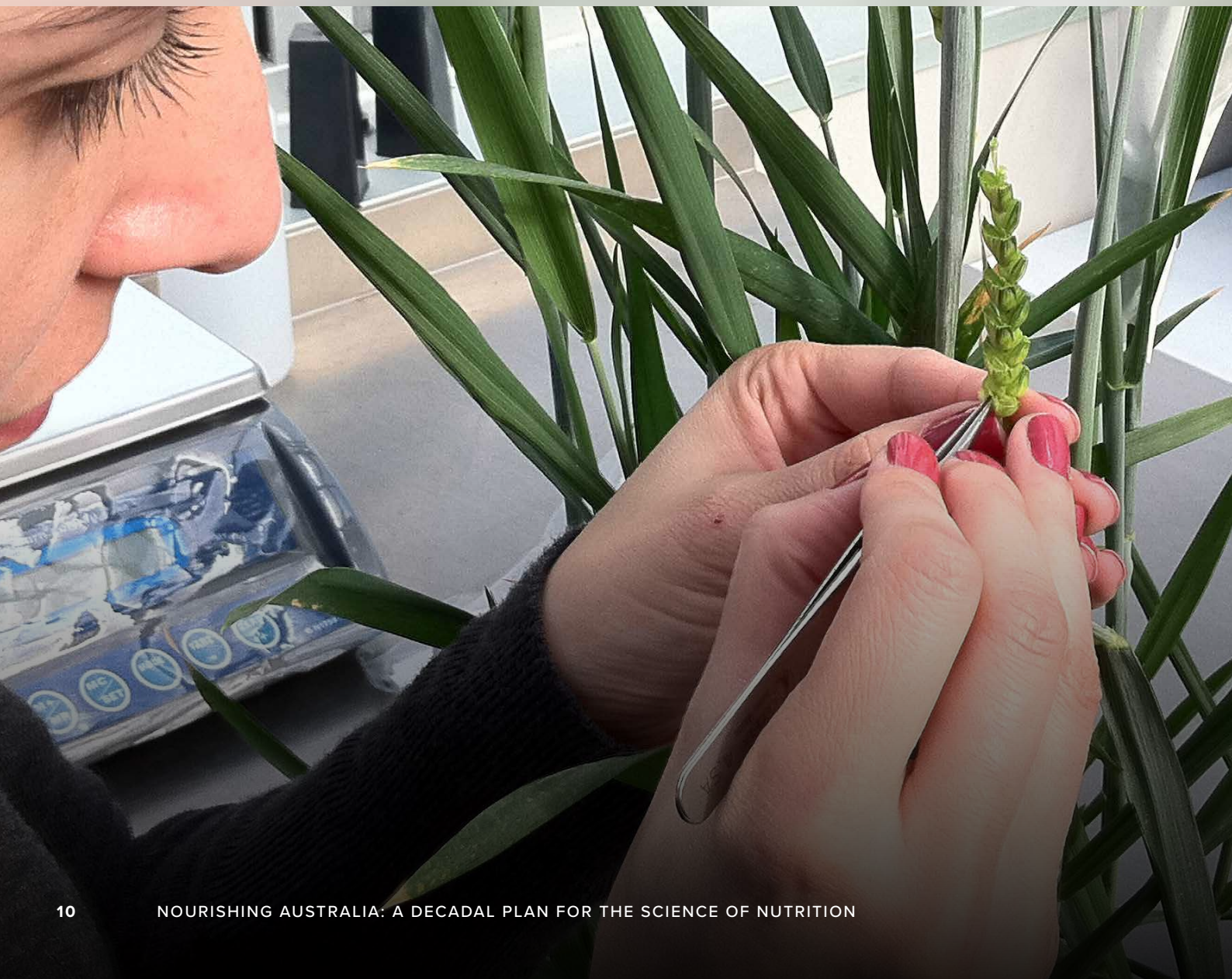
Melissa de Oliveira Santos Garcia removing anthers before making crosses in wheat.
CREDIT: ALEXANDRE GARCIA ©

It's 2030. A commitment to healthy, secure and sustainable diets has become part of the Australian national identity. New models of cross-sectoral collaboration, underpinned by evidence-based research and consistent messaging from a trusted voice, are measurably improving the national diet.

Australia's focus on the science of nutrition as a national research priority has resulted in its recognition as a global leader in identifying the mechanisms underpinning healthy diets and applying global nutrition science to develop cost-effective solutions that combat the major non-communicable diseases and diseases of ageing.

Through being a leader and investor in the science and technology of precision nutrition, targeted interventions are improving the health of nutritionally insecure Australians, and a vibrant and growing nutritech sector is providing health and economic benefits for Australia.

There is a pipeline supply of highly skilled nutrition innovators, practitioners and communicators to support the population's high level of food and nutrition literacy, achieved by integrating nutrition across diverse scientific disciplines and throughout educational curriculums from early childhood.



RECOMMENDATIONS AND IMPLEMENTATION ACTIONS

This plan recommends that **the science of nutrition becomes a national research priority** for the coming decade. This recognises the centrality of food and nutrition in addressing pressing challenges and opportunities across health, social welfare, industry and agriculture portfolios, and with consequential financial benefits through reducing healthcare costs, integrated welfare strategies, promoting productive lives and supporting the agrifood sector and development of a nutritech industry. Commitment and resources are required to embed and monitor current nutrition knowledge and dietary recommendations into agrifood and manufacturing practices and policies, social, welfare and education policies, food marketing and regulation and preventive and curative services.

Investments in complex data and omics capabilities will position nutrition as the key mediating discipline in the integration of environmental and genomic factors in determining human health, productivity and wellbeing. The biology and chemistry of nutrient sensing, decoding of signals through the conserved physiology of the gut–brain axis and the consequent influence on multiple realms of biology at individual level and beyond are now all within reach. Integrative nutrition is **the systems biology challenge of our time**, with the right combination of impact and technical stretch to be a national priority.

A further two major initiatives are recommended to ensure a high level of national impact on the future health and wellbeing of all Australians:

- The development of a living database (a **national capability for nutrition data**) of the Australian food supply, societal, welfare, commercial and media environments, dietary intake patterns, nutritional status and health outcomes of a large and representative cohort across Australia. This includes a focus on vulnerable groups such as mothers and infants, while building understanding of the social and financial challenges faced by families and communities in feeding themselves healthy, sustainable and culturally appropriate nutritious diets.

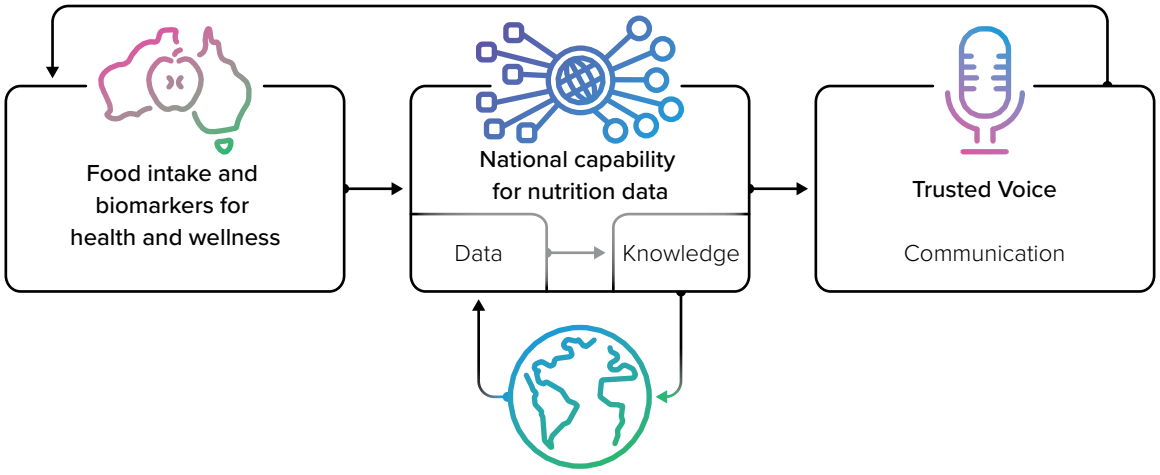
  Such a database has not yet been established in Australia, but with appropriate curation and the power of data analytics, the proposed national nutrition data capability would offer the information needed to develop, test, refine and implement a comprehensive diet system network model that is sufficiently robust to predict the results of intervention strategies.

  Practical impacts of the national nutrition data capability include national nutrition policy development based on real-world experience and robust evidence, together with monitoring, benchmarking and assessment of population-level health and welfare, nutrition equity, environmental sustainability and productivity.

- The development of a national nutrition entity (linked to the national nutrition data capability) to provide a credible, independent, evidence-based professional **trusted voice** that can use information technology and media experts to communicate the state of evidence and advice around healthy diets and fact-check/myth-bust the latest fads and health claims. The risks—both real and perceived—of bias and conflict of interest are especially acute in the case of nutrition science, and this needs to be reflected in the entity's funding, governance and editorial policies.

These recommendations cut across all four pillars of the decadal plan. Additional recommendations specific to individual pillars are detailed in relevant sections.

Realising the opportunity: from data to knowledge to impact



PILLAR 1: SOCIETAL DETERMINANTS

- **1.1** Broaden nutrition science to encompass and prioritise research into factors that influence dietary behaviour and identify effective interventions
- **1.2** Develop and test behavioural economic models to identify factors that influence consumer demand for healthy products over unhealthy processed foods
- **1.3** Establish structures to enhance cohesion of nutrition and related sciences in Australia
- **1.4** Encourage the scientific community to be proactive in exposing diet messaging based on ideology and other ulterior motives, including financial gain
- **1.5** Found a national nutrition collective, representing all stakeholder groups, that will establish approaches for modernising nutrition science and practice in Australia

PILLAR 2: NUTRITION MECHANISMS

- **2.1.1** Identify the science of nutrition as a national research priority
- **2.1.2** Enhance the profile of nutrition through increased NHMRC and ARC research funding success rates
- **2.1.3** Position the science of nutrition as a priority for the MRFF
- **2.1.4** Ensure that fit-for-purpose conceptual and experimental frameworks, facilities, measurement tools and modelling capabilities are available
- **2.2.1** Identify data collection approaches that can be connected to and analysed by a national capability for nutrition data
- **2.2.2** Harness methods to analyse complex and diverse data using shared national facilities
- **2.3.1** Articulate the challenge of integrating across diverse physiologies to define program and project opportunities
- **2.3.2** Provide training to higher degree research students and early- and mid-career researchers in the science of nutrition to build human capacity
- **2.3.3** Ensure that fit-for-purpose facilities, measurement tools and modelling capabilities are widely available
- **2.4.1** Plan and obtain support for measurement and communication of nutritional attributes of premium Australian foods
- **2.4.2** Identify and realise opportunities for premium products (foods, meals, diets) of Australian origin

PILLAR 3: PRECISION AND PERSONALISED NUTRITION

3.1.1 Incorporate nutritional genomics into a national nutrition policy framework

3.1.2 Incorporate nutritional genomics and precision nutrition in nutrition, health professional and medical training within educational institutions

3.1.3 Research the cost-effectiveness of nutritional genomics and precision nutrition

3.2.1 Increase literacy in the use of the tools of information technology (such as the Internet of Things, artificial intelligence and machine learning) in nutrition and health education programs

3.2.2 Increase literacy in genetics, genomics and bioinformatics from secondary education onwards

3.2.3 Incorporate nutritional genomics as a core subject in tertiary nutrition health professional programs

3.2.4 Foster cross-disciplinary research with areas such as computer science, information science and technology, engineering and health economics

3.3.1 Ensure that researchers and ethical boards prioritise keeping abreast of technological shifts in digital tools and genomics to maintain the ability to guard privacy and confidentiality and maintain trust

3.3.2 Encourage researchers to actively engage the public in precision and personalised research and discourse

3.3.3 Develop professional policies regarding human–subject research, data privacy, clinical practice standards and public health goals in precision and personalised nutrition

3.3.4 Embed cross-disciplinary ethical analysis (for example, between law, social science, humanities, political science and the public) into collaborations from inception

3.4 Cultivate evidence-based responsible research and innovation to best serve public safety and health through:

- **i.** fostering training and research in precision and personalised nutrition
- **ii.** ensuring ongoing independent evaluation and synthesis of commercial precision and personalised nutritech products
- **iii.** promotion of commercial and science partnerships to foster innovation in evidence-based precision and personalised nutritech products
- **iv.** developing sustainable and independent precision and personalised nutrition science platforms that assess and synthesise data on an ongoing dynamic basis
- **v.** ensuring researcher transparency by disclosing conflict of interests of all involved parties
- **vi.** ensuring decisions are informed by scientific evaluation of the available evidence in cases where insurance coverage of precision and personalised nutrition products services is proposed

PILLAR 4: EDUCATION AND RESEARCH TRAINING

4.1.1 All professional nutritionists undertake competency-based education

4.1.2 All nutrition courses adopt a code of ethics and their graduates are fit to practice

4.2 Harness the scope and reach of social media, the internet and other mass communication channels to enable nutrition professionals to communicate to the public effectively and efficiently

4.3 Integrate nutrition education, including food skills, across all formal education (early childhood, school, TAFE and tertiary)

4.4 Ensure evidence-based teaching, including societal determinants and the ethics of precision and personalised nutrition, as core competencies in all accredited and professional development courses

4.5.1 Develop clear career pathways and opportunities in research, public health and advocacy roles

4.5.2 Develop a training framework of competency from basic to advanced levels in line with these career pathways

4.6 Incorporate leadership training in professional development courses by leveraging existing nutrition leadership platforms, such as the Oceanic Nutrition Leadership Platform

PILLAR 1
SOCIETAL DETERMINANTS
Nutrition in context

Insight	Aspiration	Actions	Impacts	Metrics
Insight 1.1 If followed more broadly, existing evidence-based dietary guidelines would lead to substantial health improvements in Australians	**Aspiration 1.1.1** The factors that prevent Australians from following dietary guidelines are understood **Aspiration 1.1.2** Effective interventions targeting these factors are implemented	**Action 1.1** Broaden nutrition science to encompass and prioritise research into factors that influence dietary behaviour and identify effective interventions	**Impact 1.1** Improved Australian diet quality	**Metric 1.1** Greater adoption of the principles of dietary guidelines
Insight 1.2 Competition between health objectives and commercial interests impacts negatively on the quality of Australian diets and health	**Aspiration 1.2** A culture shift in Australia sees consumer demand and industry capability increase the market competitiveness of healthy alternatives to unhealthy processed foods	**Action 1.2** Develop and test behavioural economic models to identify factors that influence consumer demand for healthy products over unhealthy processed foods	**Impact 1.2** A new generation of agrifood products that retain the benefits of food processing without negative health impacts	**Metric 1.2** Reduction in the preponderance of unhealthy processed foods that displace healthy alternatives
Insight 1.3 Substantial negative impacts on diet and health derive from 'spurious uncertainty', where legitimate debate among nutrition experts is exaggerated or twisted to undermine evidence-based knowledge. This is called the 'tobacco control playbook', as it is the modus operandi of the tobacco industry for undermining the scientific evidence associating its product with disease	**Aspiration 1.3** The Australian nutrition science community has a trusted and authoritative voice representing the best scientific evidence. This does not preclude scientific debate, which is essential for scientific progress, rather, it: i. authoritatively delineates information around which there is consensus in nutrition science from information that is subject to varying degrees of uncertainty ii. exposes cases where these categories are disingenuously conflated for self-interest, such as financial or ideological motives iii. acts as a point of evidence collation for government consultation and advocacy to government and other groups	**Action 1.3** Establish structures to enhance cohesion of nutrition and related sciences in Australia	**Impact 1.3.1** The nutrition science community is unified around a solid foundation of well-established evidence-based information on the links between diets and health **Impact 1.3.2** Hypotheses and equivocal facts are clearly delineated from those sufficiently well established to inform nutrition messaging, policy and commercial strategy	**Metric 1.3.1** Improved public perception of the nutrition science community **Metric 1.3.2** Enhanced clarity and transparency on what is evidence-based fact, what is conjecture and what is misinformation in nutrition
Insight 1.4 Misinformation about the links between diet and health has the potential to be a serious public health hazard	**Aspiration 1.4** There is a culture of accountability that moderates unconstrained and self-serving claims in the public arena about links between diet and health. No such restraint applies in other arenas, including media, diet book industry, internet bloggers, etc	**Action 1.4** Encourage the scientific community to be proactive in exposing diet messaging based on ideology and other ulterior motives, including financial gain	**Impact 1.4** A shift from the postmodern diet culture in which unqualified and conflicted views are considered on par with evidence-based nutrition	**Metric 1.4** Greater clarity in public messaging around what is opinion and what is evidence-based information
Insight 1.5 Societal influences on dietary behaviour are extraordinarily complex and difficult to manage. They are nested within a web of conflicting attitudes, perceptions and motives, which inevitably will demand that compromises, rather than pure solutions, are achieved	**Aspiration 1.5** An expanded nutrition science that encompasses multidisciplinary and cross-sectoral expertise to tackle these complex issues	**Action 1.5** Found a national nutrition collective, representing all stakeholder groups, that will establish approaches for modernising nutrition science and practice in Australia.	**Impact 1.5.1** An unparalleled capacity for efficiently tackling the burden of malnutrition by targeting the most effective interventions **Impact 1.5.2** Increased common purpose among different stakeholders through pursuing solutions that are mutually beneficial, such as processed foods that are both profitable and healthy	**Metric 1.5.1** Improved Australian dietary patterns **Metric 1.5.2** Better food options in retail outlets and restaurants **Metric 1.5.3** Increased quantity and quality of scientific outputs **Metric 1.5.4** New directions for growth in the food industry

It's 2030. Australia is recognised globally as a best practice model for integrating dietary and environmental factors for the food system, which has resulted in successful targeted interventions for health and wellness improvement.

Through a focus on the science of nutrition as a national priority, social and environmental sciences are fully integrated with biological sciences to create multi-system models that have resulted in evidence-based policymaking at the intersection of health, agrifood and environment sectors.

Insights from identifying the role of societal factors in determining diet, behaviours and health outcomes have informed approaches to achieving the Sustainable Development Goals and equitable access to a safe and nutritious food supply for all Australians.

Background

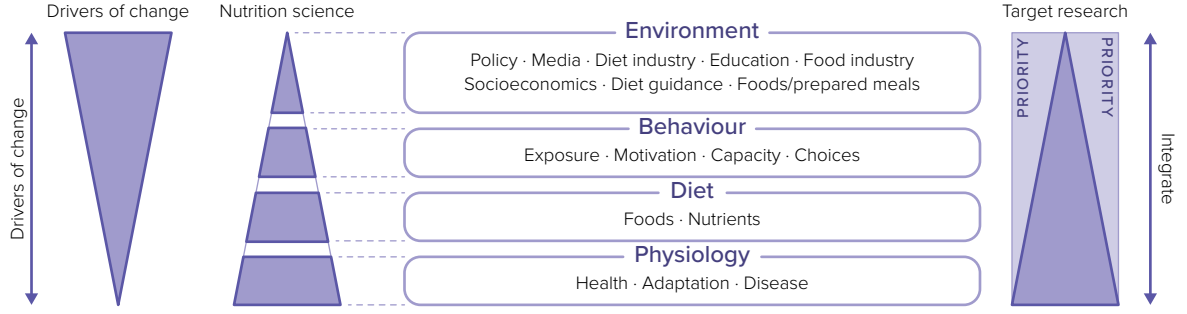
Diet-associated health outcomes are determined by a complex relationship between biology, behaviour and societal environment and underpinned by issues of equity of access to nutritious food. Nutrition science is concerned with the biological aspects that examine the effects of different patterns of food consumption on physiology and health: the biomedical model. This approach has driven significant advances in understanding how nutrition influences biology, yielding improvements in the understanding of human dietary requirements and the treatment and management of non-communicable disease. There is more yet to do in this important realm (pillars 2 and 3).

However, there has been little progress in translating nutrition research into disease *prevention*. Greater emphasis is needed on the societal issues that influence dietary behaviour. The societal environment, including such issues as food supply policy, marketing, education and media, plays a powerful role in influencing dietary behaviour. Indeed, the current epidemic of nutrition-related non-communicable diseases has resulted not from changes in human physiology or nutrient requirements, but from societal changes involving increased industrialisation and globalisation of food systems, among other factors.

There is an urgent need to broaden nutrition science to prioritise research on the role of the complex dynamics of modern food environments and their effects on behaviour. This will complement research into diet–nutrient–physiology interactions, with an understanding of why humans are prone to eating diets that expose our physiology to either healthy or unhealthy nutrient intakes. An integrated approach will provide better insight into the immensely complex and challenging role of societal environments in diet and nutrition, and identify key control points that can feasibly be targeted to effect positive change.

An expanded model of nutrition science, as illustrated below, is needed. This model prioritises research into the environmental drivers of dietary behaviour and integrates societal influences on diet with downstream biochemical, physiological and health consequences. A model that is both interdisciplinary and cross-sectoral can provide a framework for developing a national nutrition collective representing many stakeholders that are instrumental in influencing the food chain, consumer behaviour and, ultimately, health.

Relevant stakeholders include policymakers, the agrifood sector, food industry, educators, hospitality industry, retailers and health promoters, the media and others who communicate messages to the lay public. An initial and seminal step in building the framework for a collective would be to seek national-level commitment to shift towards healthier diets. Among its many functions, the collective would mediate the often-conflicting interests of different sectors to identify mutually beneficial ways to honour the national commitment to healthier Australians.



PILLAR 2
NUTRITION MECHANISMS
From epidemiology to cause-and-effect relationships

Insight	Aspiration	Actions	Impacts	Metrics
Insight 2.1 A new science of nutrition is needed that moves away from a focus on single nutrients and commodities to consider the *interactions* between multiple nutrients and the biological mechanisms that define health outcomes, and in turn relates these to dietary patterns as the drivers of human health, wellness and productivity	**Aspiration 2.1** Australia integrates its expertise in biological, medical and other sciences to play a major role in discovering the mechanisms by which nutrients and dietary patterns promote health, wellness and productivity	**Action 2.1.1** Identify the science of nutrition as a national research priority **Action 2.1.2** Enhance the profile of nutrition through increased NHMRC and ARC research funding success rates **Action 2.1.3** Position the science of nutrition as a priority for the MRFF **Action 2.1.4** Ensure that fit-for-purpose conceptual and experimental frameworks, facilities, measurement tools and modelling capabilities are available	**Impact 2.1** Australia plays a major role in the global effort to define the mechanisms underpinning healthy diets and dietary routes to combatting all the major non-communicable diseases	**Metric 2.1** New knowledge generates outcomes that are integrated into patient care at primary and tertiary levels
Insight 2.2 Conventional nutrition science methodologies will be enhanced and integrated with web-based citizen science data collection methods and complex data analyses	**Aspiration 2.2** Datasets on food intake and health, wellness and biomarker outcomes from the national capability for nutrition data are combined with laboratory and controlled clinical trials to propose, test and refine systems-level cause-and-effect mechanisms between diet and health/wellness	**Action 2.2.1** Identify data collection approaches that can be connected to and analysed by a national capability for nutrition data **Action 2.2.2** Harness methods to analyse complex and diverse data using shared national facilities	**Impact 2.2** A greater efficiency of nutrition data collection, analysis and linkage across scales, from experimental to population level	**Metric 2.2.1** Evidence of increased usage and linkage of data from existing and new sources **Metric 2.2.2** Demonstrated consilience of evidence from different sources being used to shape nutrition policy
Insight 2.3 The combined responses of metabolic, immune, microbiome, neural, endocrine and other systems to combinations of nutrients and dietary patterns represent the next great challenge in systems biology	**Aspiration 2.3** The ways that diets interact with human physiology and biochemistry are defined sufficiently to identify and demonstrate opportunities for nutrition to enhance wellness and productivity	**Action 2.3.1** Articulate the challenge of integrating across diverse physiologies to define program and project opportunities **Action 2.3.2** Provide training to higher degree research students and early- and mid-career researchers in the science of nutrition to build human capacity **Action 2.3.3** Ensure that fit-for-purpose facilities, measurement tools and modelling capabilities are widely available	**Impact 2.3** A systems understanding of diet and health that: • enables precision and personalised nutrition programs to prevent and manage chronic diseases and optimise health against multiple criteria across the life course (see pillar 3) • informs the design of food production and manufacturing systems to take account of health outcomes, equity, and economic and environmental sustainability	**Metric 2.3.1** Australia is a leading nation in the science of precision nutrition (see pillar 3) **Metric 2.3.2** Evidence that measures of health, equity and sustainability are key currencies in the design and optimisation of the national food and nutrition system
Insight 2.4 Australia is a producer of all components in healthy diets. Nutrition credentials can provide the route to achieving premium product value, particularly for exports	**Aspiration 2.4** Recognition as a leader in the science of nutrition provides Australia with a market advantage in the high-value foods export sector	**Action 2.4.1** Plan and obtain support for measurement and communication of nutritional attributes of premium Australian foods **Action 2.4.2** Identify and realise opportunities for premium products (foods, meals, diets) of Australian origin	**Impact 2.4.1** Australian food is associated with nutritional quality that can be tracked through the supply chain, as well as clean/green production practices **Impact 2.4.2** High nutritional-value foods with distinctively Australian attributes provide a boost to the agrifood sector	**Metric 2.4.1** Increase in value of exports as a result of their nutritional credentials and marketing **Metric 2.4.2** Increase in value of farmgate production as a result of measurable nutrition credentials

It's 2030. Australia's research community has embraced nutrition as the paradigm for integrative science, attracting many of its brightest research scientists to the field, integrating outcomes into patient care at primary and tertiary levels and stimulating waves of commercial innovation.

Through integration of approaches from population to molecular levels, credible hypotheses for nutritional mechanisms influencing major non-communicable disease prevention and human performance have been derived.

A stream of health-promoting premium products from the Australian agrifood sector are supported by technical insights from investments in the science of nutrition. The global recognition of Australia as a powerhouse in nutrition is an important facet of marketing exports to a growing consumer class in Asia and beyond.

Background

It is well understood that diet and dietary patterns are complex systems. However, the existing framework of nutrition science research has typically used a reductionist approach, where single micronutrients, macronutrients or individual foods are tested for their effects on specific health outcomes and physiological systems. The one-variable-at-a-time study design largely follows that of clinical research and has contributed to the development of food and nutrition policies and interventions focused on individual nutrients, commodities or foods.

Disentangling the potential influence on health outcomes of a single dietary component from these other variables is challenging, if not impossible. Rather, the focus should move towards the *interactions* between nutrients, other food constituents (such as dietary fibre and phytochemicals), the dynamic biological systems and mechanisms underpinning optimal health outcomes, and the dietary patterns that in turn yield these healthy nutrient combinations.

Whole diets are composed of complex mixtures of nutrients and non-nutrient chemicals. Individuals consume thousands of food-derived chemicals daily in multiple combinations. These chemicals interact with each other and with the body at many levels, including olfaction, taste and chemosensing, digestion and absorption, cellular metabolism for energy production, fermentation by the gut microbiota and production of *de novo* metabolites and excretion.

All facets of the effects of foods have the potential to regulate the body's processes and lead to wellness or the development of chronic diseases. It is becoming apparent that a more holistic approach should be considered when studying the interaction of diet (foods and nutrients) with physiological, metabolic and immunological systems. Such a systems approach would result in new ways of approaching, analysing and solving nutrition challenges.

A crucial limitation in nutrition science is the difficulty of measuring what people actually eat. There is an urgent need to develop field-validated tools and digital technologies for dietary assessment at population scale, as well as biomarkers of nutrient intake, that can be used in cohort and clinical trials. Although randomised control trials (RCTs) must still have a place in the assessment of dietary patterns, there is a need to move beyond consideration of average responses of the groups under study to consider the variance in individual responses. Indeed, within a group of participants there will be responders and non-responders to any particular intervention, in part because of varying genotypes, epigenotypes, metabolic profile and environmental exposures. Additionally, since RCTs are expensive, lengthy and labour intensive, a modified approach should be taken wherein greater data and biological samples are collected and stored for retrospective analyses. This approach should also include a qualitative arm to assist with understanding people's experience and perspective.

Due to advances in smartphone and web technology, epidemiological studies have the potential to provide much richer datasets. This 'living epidemiology' that exists under the umbrella of citizen science involves public participation and collaboration with ongoing measurement in real time and storage of those measurements (see case study of the American Gut Project). Collection of these enormous datasets enables both the identification of outcomes in the short and medium term and of hypotheses for cause-and-effect mechanisms that can also be tested under more controlled conditions. Complex data analysis is a critical enabler, making this approach both timely and important.

One consequence of the realisation that whole foods (rather than single nutrients) are the drivers of nutrition is that the ways agricultural materials are processed first into foods and then during digestion become important. The physical structure of foods is now

understood to be intimately linked with nutritional outcomes through controlling the rate (and hence often the site) of delivery of individual components within the gastrointestinal tract. The kinetics of food and nutrient uptake are vital in controlling hormonal responses and determining which parts of the diet are digested by human enzymes in the upper gastrointestinal tract and which become the feedstock for the gut microbiota in the lower tract.

There has been a recent surge of interest in the gut microbiome as a mediator of nutritional responses. This means that defining its dietary feedstock and the ways that fermentation results in influences on hormonal, immune, neural and other physiologies is now an intimate part of the science of nutrition.

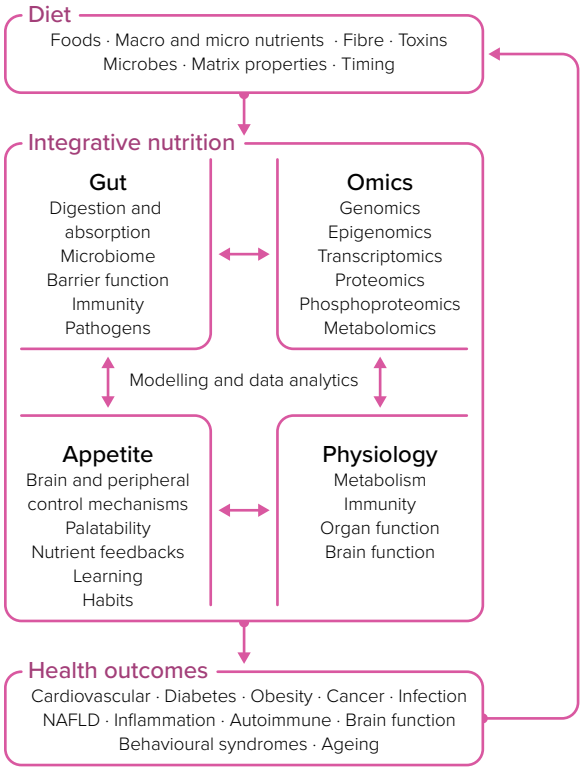
Our understanding of diet-related biological pathways will continue to expand, highlighting the limitations of using single surrogate outcomes to determine the health effects of any dietary factor. A systems biology approach will enable the mapping of multiple surrogate endpoints and establish signatures in wellness/health and in disease.

This would involve integration of biomarkers from gastrointestinal bacteria to host, for example, from saliva, blood, urine and gut microbiota, and consist of immunomodulatory mediators (immune cell activation, cytokine/chemokine production), metabolites (microbial, host and food derived), vitamins, hormones and genes that are quantitated using omics technologies (metagenomics, transcriptomics, metabolomics, proteomics and others), with a focus on diet composition rather than single nutrients.

Rather than an over-reliance on RCTs that are more suited to nutrient-level mechanisms, the combination of data from controlled interventions, using a diverse range of biomarkers with mechanism-of-action studies and prospective observational studies, will be required to derive robust mechanistic relationships between diet and health and wellbeing.

The influence of nutrition on brain activity promises to be another pertinent area of research during the next decade, as signals originating from the metabolism of foods, including via the gut microbiota, are identified and the role of these metabolites in influencing neural processes are determined. This will result in dietary options for better controlling neural responses to food, such as through chemosensory cues and satiety signals.

There is great potential to identify nutrition-based therapies and preventive treatments for chronic neurodegeneration in the ageing population. In addition, the role of nutrition in improving brain function through sharper mental acuity, greater ability to concentrate, memory retention and so on, will begin to be understood, promising new diet-based approaches to enhancing human capacity.



The components and interrelationships that need to be integrated for a systems understanding of diet and health, which could be used to inform the design of food production and manufacturing systems to take account of health outcomes, equity, economic and environmental sustainability

CASE STUDY
THE AMERICAN GUT PROJECT

Website: www.americangut.org

The American Gut Project, the world's largest crowd-sourced research project on the microbiome, was established in 2012. The aim was to collect a comprehensive dataset on the diversity of micro-organisms living in the gut and on the human body, to relate these microbial communities to health and lifestyle and to track trends in the composition of the microbiome across space and time.

For US$99, participants receive a kit for collecting a microbiome sample (typically stool) and a voluntary questionnaire on general health status, disease history, lifestyle and diet. Samples are posted to a research team led by Professor Rob Knight in the School of Medicine at the University of California San Diego, who process the samples using a genetic barcoding technique and provide participants with an educational report detailing the microbes living in their gut. These data are de-identified and made publicly available to researchers worldwide in open-source data repositories.

Through The Microsetta Initiative (microsetta.ucsd.edu), the project links to an equivalent in Britain, the British Gut Project, and has an aggregation site in Australia run by Professor Phil Hugenholtz at the University of Queensland. As of mid-2017, data has been collected from more than 11 000 people, mainly from the USA, UK and Australia, along with 42 other countries or territories. The project and its UK affiliate have received more than US$2.5 million from crowdfunding, with the work of the scientists supported through additional philanthropic and national competitive grant funding.

PILLAR 3 PRECISION AND PERSONALISED NUTRITION

Targeted responses to foods and diets

Insight	Aspiration	Actions	Impacts	Metrics
Insight 3.1 Recent and future technological advances will allow the determination of a wide range of data about an individual's genetic and biochemical makeup, as formed by their genes, life stage, health status, environment and lifestyle—at an increasingly lower cost. These data can be applied to help people live longer and better lives by changing the way we prevent, diagnose, treat and monitor both illness and wellness	**Aspiration 3.1** A high-level nutrition policy and implementation plan provides the capacity, capability and infrastructure needed to support integration of nutritional genomic technology into the national health system	**Action 3.1.1** Incorporate nutritional genomics into a national nutrition policy framework **Action 3.1.2** Incorporate nutritional genomics and precision nutrition in nutrition, health professional and medical training within educational institutions **Action 3.1.3** Research the cost-effectiveness of nutritional genomics and precision nutrition	**Impact 3.1** Australia becomes a global leader in precision nutrition and health genomics, resulting in improved wellbeing, greater productivity and more cost-effective disease prevention and management for Australians, as well as exportable technologies and programs that generate economic benefit	**Metric 3.1.1** Number of national and state policies in precision health that incorporate nutrition **Metric 3.1.2** Proportion of educational institutions that incorporate nutritional genomics and precision nutrition in health professional and medical training **Metric 3.1.3** Number of evidence-based, cost-effective precision nutrition treatments and programs translated into the health sector
Insight 3.2 A plethora of genetic, biological and phenotypic data requires technology tools to synthesise and realise the potential of precision and personalised health and nutrition in improving wellbeing and reducing and treating diet-related disease	**Aspiration 3.2** Australia is a world leader in cutting-edge nutrition data science and technology that turns data into action and improves the quality and cost-effectiveness of treatment, disease prevention and health optimisation	**Action 3.2.1** Increase literacy in the use of the tools of information technology (such as the Internet of Things, artificial intelligence and machine learning) in nutrition and health education programs **Action 3.2.2** Increase literacy in genetics, genomics and bioinformatics from secondary education onwards **Action 3.2.3** Incorporate nutritional genomics as a core subject in tertiary nutrition health professional programs **Action 3.2.4** Foster cross-disciplinary research with areas such as computer science, information science and technology, engineering and health economics	**Impact 3.2.1** Nutrition researchers develop innovative methods and tools in data analytics, research design, health informatics and bioinformatics **Impact 3.2.2** Tertiary nutrition education teaches integration of systems biology with non-biological systems **Impact 3.2.3** Researchers and health professionals are proficient in mainstream and state-of-the-art point-of-care biological and behavioural measurement tools that provide data at individual and population levels	**Metric 3.2.1** Australia's ranking and growth in numbers of peer-reviewed precision and personalised nutrition publications **Metric 3.2.2** Citation ranking of Australian researchers in precision and personalised nutrition in international information technology journals
Insight 3.3 Participation in self-health management by consumers and patients is a rapidly growing feature of a more democratised health system, where the person is better informed through greater health and nutrition literacy and demands more control of decisions relating to their health and wellbeing	**Aspiration 3.3.1** Australia has achieved ethical, legal and socially just precision and personalised nutrition solutions **Aspiration 3.3.2** The ethics of precision and personalised nutrition is a core competency in all fields of nutrition training and education	**Action 3.3.1** Ensure that researchers and ethical boards prioritise keeping abreast of technological shifts in digital tools and genomics to maintain the ability to guard privacy and confidentiality and maintain trust **Action 3.3.2** Encourage researchers to actively engage the public in precision and personalised research and discourse **Action 3.3.3** Develop professional policies regarding human–subject research, data privacy, clinical practice standards and public health goals in precision and personalised nutrition **Action 3.3.4** Embed cross-disciplinary ethical analysis (for example, between law, social science, humanities, political science and the public) into collaborations from inception	**Impact 3.3.1** High level of literacy in information technologies and biological applications relevant to precision and personalised nutrition, leading to ethical, legal and socially just research ethics applications and approvals **Impact 3.3.2** The Australian public has a high level of engagement, trust and literacy in precision and personalised nutrition and data privacy **Impact 3.3.3** Effective multidisciplinary and public collaborations inform future research, foster public trust and engagement and develop responsive law and policy regarding emerging technologies	**Metric 3.3.1** Number of research projects that engage consumers in the planning process **Metric 3.3.2** Number of nutrition training programs that address the ethics of precision and personalised nutrition **Metric 3.3.3** Number of nutrition training programs that incorporate data privacy in research methodology

Insight	Aspiration	Actions	Impacts	Metrics
Insight 3.4 Private investment in individual and population health and wellness technologies is growing, with a wide range of tech investors and venture capitalists making significant contributions. Australia has the opportunity to capture the health and economic benefits of a rapidly growing precision and personalised nutritech sector	**Aspiration 3.4** Australia is a global leader in evidence-based precision and personalised nutritech products and services that improve individual and public health and safety, for both Australian and international markets	**Action 3.4** Cultivate evidence-based responsible research and innovation to best serve public safety and health through: i. fostering training and research in precision and personalised nutrition ii. ensuring ongoing independent evaluation and synthesis of commercial precision and personalised nutritech products iii. promotion of commercial and science partnerships to foster innovation in evidence-based precision and personalised nutritech products iv. developing sustainable and independent precision and personalised nutrition science platforms that assess and synthesise data on an ongoing dynamic basis v. ensuring researcher transparency by disclosing conflict of interests of all involved parties vi. ensuring decisions are informed by scientific evaluation of the available evidence in cases where insurance coverage of precision and personalised nutrition products services is proposed	**Impact 3.4.1** Australian researchers have a high level of literacy in the science and commercialisation of precision and personalised nutritech research **Impact 3.4.2** Increased number of funded research projects related to precision and personalised nutrition and nutritech applications **Impact 3.4.3** Increased number of researchers in the science and commercialisation of precision and personalised nutrition and nutritech research **Impact 3.4.4** Increased number of evidence-based precision and personalised nutrition products **Impact 3.4.5** Health and economic evaluation of commercialised evidence-based precision and personalised nutrition and nutritech products	**Metric 3.4.1** High level of literacy in the science and commercialisation of precision and personalised nutritech research **Metric 3.4.2** Increased number of researchers in precision and personalised nutritech fields **Metric 3.4.3** A science platform established with ongoing evidence-based precision and personalised nutritech products **Metric 3.4.4** Increased numbers of evidence-based precision and personalised nutritech products with business models that achieve positive health and economic outcomes **Metric 3.4.5** Increase in products and commercial revenue from evidence-based nutritech products **Metric 3.4.6** Numbers of successful nutritech businesses with domestic and/or global reach

It's 2030. Australia is a leader in the science and technology of precision and personalised nutrition, resulting in health outcomes that benefit Australians and a vibrant, growing nutritech industry.

By adopting precision nutrition approaches in the healthcare system, benefits have been realised in the greater use of targeted dietary interventions, which has reduced the burden of chronic diseases.

The Australian nutritech sector has developed a suite of measurement, diagnostic and advisory tools that have been successful worldwide, enhancing the nation's reputation in the medical technology sector.

Background

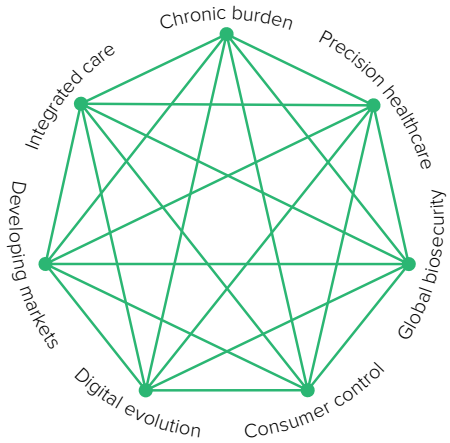
We are in an era that has seen the advancement of genomic and information science and technologies lead to an explosion of data (on genes, metabolites, environment and lifestyle) and associated analytics that allows more sophisticated healthcare solutions with greater precision. These developments are leading to a new, efficient and innovative health economy, resulting in more cost-effective health and disease management. The accessibility of web-based health and medical knowledge is shifting the balance of health management towards the consumer and patient, who are becoming empowered and engaged in their own health management.

The US and Europe have strategic long-term priorities in precision health and medical research, including policies and substantial public investment. The following reports have been produced in Australia:

- *The future of precision medicine in Australia*, published in 2018 by the Australian Council of Learned Academies: acola.org/hs2-precision-medicine-australia
- *Medical technologies and pharmaceuticals roadmap*, published in 2017 by CSIRO Futures: www.csiro.au/en/Do-business/Futures/Reports/Medical-Technologies-and-Pharmaceuticals-Roadmap
- *The national health genomics policy framework 2018–2021*, published in 2017 by the Council of Australian Governments Health Council: www.coaghealthcouncil.gov.au/Publications/Reports

Private investment in medical and health technologies is also growing, with non-traditional health investors such as Google, Microsoft and venture capitalists making significant contributions. It has been suggested that, with the leap in biotechnology investment and a sharp drop in pharmaceutical investment, investors are now turning to population health, wellness apps and at-home or on-the-go wellness monitoring.

Nutrition science, as a key driver of health, has also been developing and adopting the tools of personalisation and precision, which apply equally well in improving or preventing disease in clinical settings as they do in optimising health and wellness. A culture focused on maintaining and improving health and wellness is emerging, fostered by government as well as the food, healthtech and nutritech industries. It is important to note that precision nutrition solutions are no different to those for population nutrition, that is, they are likely to be based on dietary patterns rather than individual nutrients or foods.



A personalised and integrated approach to public health

Precision and personalised nutrition: definition and technology enablers

The technologies that lead the development of precision and personalised nutrition are phenotype-validated genetics, genomics and microbiome datasets. However, the innovations are not limited to the biological dimensions alone, as technologies that precisely describe environmental and behavioural characteristics (such as the Global Positioning System) are important features of the health informatics ecosystem. Additionally, technology tools (such as mobile applications, machine learning and virtual reality) and continuous real-time biological data (such as glucose and blood pressure) provide opportunities for both better management of health data and improved population experience and literacy in health and nutrition.

A focus on precision and personalised nutrition will result in:

- new methods in data analytics and bio and health informatics (such as machine learning and dynamic Bayesian modelling)
- new research design methodologies
- integration of systems biology with non-biological systems
- proficiency in mainstream and state-of-the-art point of care
- biological and behavioural measurement tools that provide real-time data at individual and collective levels
- new tech tools, such as genomic platforms (SNPedia, Ensembl, etc.), mobile applications, products and services that curate and facilitate data analytics.

Definitions

Personalised Nutrition (n=1)

Preserve or increase health using genetic, phenotypic, medical, nutritional and other relevant information about individuals to deliver more specific and effective nutritional guidance, products and services.

Precision Nutrition (n=groups/populations)

Preserve or increase health using genetic, phenotypic, medical, nutritional and other relevant information about groups and populations to deliver more tailored and cost-effective interventions, products and services.

Dr Emma Beckett is exploring the genetic secrets behind microbiomes and whether you really are what you eat.
CREDIT: EDDIE O'REILLY©

PILLAR 4 EDUCATION AND RESEARCH TRAINING

Insight	Aspiration	Actions	Impacts	Metrics
Insight 4.1 There are many and varied groups that provide a 'cacophony of noise' from which consumers must synthesise the 'truth' about food and nutrition	**Aspiration 4.1** Nutrition professionals, supported by a national trusted voice, are the source of food and nutrition advice	**Action 4.1.1** All professional nutritionists undertake competency-based education **Action 4.1.2** All nutrition courses adopt a code of ethics and their graduates are fit to practice	**Impact 4.1** The public can easily identify nutrition professionals and have confidence in their fitness to practice and scope of practice	**Metric 4.1** Statutory title for nutrition professionals with a single code of conduct
Insight 4.2 There is a need to communicate the complexity of nutrition with a unified voice	**Aspiration 4.2** The general public has a greater understanding of the complexity of nutrition science and its impact on their food choices and dietary patterns	**Action 4.2** Harness the scope and reach of social media, the internet and other mass communication channels to enable nutrition professionals to communicate to the public effectively and efficiently	**Impact 4.2** Greater unity and impact achieved through understanding consumer behaviour and improved engagement with consumer groups and sub-groups	**Metric 4.2** Nutrition professionals measure their engagement and effectiveness by changes in the public's diet quality
Insight 4.3 Nutrition education for the whole, broader population is required	**Aspiration 4.3.1** Every Australian has a basic understanding of cooking skills, nutrition and how their food choices and dietary patterns impact their long-term health and that of their family **Aspiration 4.3.2** The public have a greater understanding of the complexity of nutrition science and its impact on their food choices and dietary patterns	**Action 4.3** Integrate nutrition education, including food skills, across all formal education (early childhood, school, TAFE and tertiary)	**Impact 4.3** The public has a basic knowledge of nutrition and greater skills in synthesising and applying this knowledge to their food choices	**Metric 4.3** A high level of food literacy and food skills in the population
Insight 4.4 Upskilling nutrition professionals is required in emerging research areas that impact on practice and public understanding of the science of nutrition	**Aspiration 4.4** Researchers actively engage the public in nutrition research and discourse	**Action 4.4** Ensure evidence-based teaching, including societal determinants and the ethics of precision and personalised nutrition, as core competencies in all accredited and professional development courses	**Impact 4.4** Nutrition professionals engage and influence the public with messages about evidence-based nutrition	**Metric 4.4** All accredited courses include learning outcomes that reflect new nutrition research methodologies, including societal determinants, nutritional genomics and complex data analysis
Insight 4.5 The number of nutrition professionals in Australia is small. Career pathways appear limited and lack clarity	**Aspiration 4.5** Australia is seen as the leader in the education and training of nutrition researchers, educators and public health nutritionists for the Asia-Pacific region	**Action 4.5.1** Develop clear career pathways and opportunities in research, public health and advocacy roles **Action 4.5.2** Develop a training framework of competency from basic to advanced levels in line with these career pathways	**Impact 4.5** There is a greater number of nutrition professionals trained and retained in the workforce	**Metric 4.5.1** Increased proportion of nutrition professionals with higher degrees and demonstrable competence in research and/or public health **Metric 4.5.2** Increased number of nutrition professionals with nationally awarded competitive fellowships
Insight 4.6 Leadership paradigms are changing from residing in single disciplines and individuals to leadership as a collective, multidisciplinary process throughout networks of people. Leadership training, capacity development and ongoing support networks are necessary features of a strong nutrition workforce	**Aspiration 4.6** A network of nutrition leaders skilled in complex and adaptive thinking, with foresight, broad vision and who work collaboratively across disciplines and sectors to positively influence food systems and nutrition	**Action 4.6** Incorporate leadership training in professional development courses by leveraging existing nutrition leadership platforms, such as the Oceanic Nutrition Leadership Platform	**Impact 4.6** Enhanced ability to operationalise nutrition policies and strategies that will impact health and wellbeing for all	**Metric 4.6.1** Increased number of nutrition professionals in leadership positions **Metric 4.6.2** Increased number of outputs/ outcomes from collaborative activities **Metric 4.6.3** Increased number of multi-disciplinary/ multi-sector collaborations (such as working groups, coalitions, etc.)

It's 2030. Improved population diet quality through informed food choices has been achieved by optimal communication of the science of nutrition, through consistent evidence-based messages and by understanding and harnessing contemporary communication channels.

By upskilling established nutrition professionals in new opportunities arising from data analytics, genomics and other omics and digital technologies, Australia has a workforce capable of delivering a new era of opportunity for the science of nutrition, with diverse and rewarding career pathways.

An academy of nutrition has been established that brings together nutrition professionals and credentialing bodies, is recognisable to the public and adopts a common code of conduct.

High-quality nutrition educators are providing education and training resources to all regions of Australia and its international neighbours. Australia actively supports the nutritional health of the Asia-Pacific region with a workforce that has advanced capabilities and competencies in the translation of nutrition science into practice, public health policy and planning, advocacy skills, systems thinking and communication skills.

Nutrition education is provided to key professionals of broad disciplines, including education (teaching youth to improve food and nutrition literacy) and health professionals (who have exposure to more individuals than nutrition professionals alone). Basic nutrition knowledge is integrated into curricula across primary, secondary and tertiary education.

A network has been established of nutrition leaders skilled in complex and adaptive thinking, with foresight and broad vision, who work collaboratively across disciplines and sectors to positively influence food systems and nutrition.

Background

Within the context of the global burden of disease, poor dietary patterns are responsible for more deaths than any other modifiable risk factor in non-communicable disease, excluding smoking. High body mass index and metabolic conditions such as hyperglycaemia and hypertension may be preventable and treatable by optimising dietary patterns and increasing activity across the population.

Certain life stages, such as during pregnancy and early life, are important windows of opportunity for nutritional interventions to have the greatest impact on an individual's lifelong health prospects, that of their children, on human capital and for national economic prosperity. Despite the potential for dietary patterns to have substantial impact on health outcomes, the low adoption of an optimal 'dietary pattern for health' indicates that communication of nutrition science is not yet succeeding.

Communicating with a trusted voice

Developing the expertise and reputation of nutritionists as trusted sources of nutrition information is vital. A new unified regulatory system will evolve that aims to protect the public from poor advice from unqualified individuals or those outside their scope of practice in differing parts of the nutrition workforce.

Gaining the public's trust in scientists with recognised nutrition qualifications is crucial to the success of the decadal plan's proposed trusted voice. There is a need for the public to recognise and differentiate the qualifications of scientifically educated professionals so they can make an informed choice.

Developing the profession of nutrition scientist will require a common title and a code of conduct to ensure professional standards are identifiable and upheld. Pivotal to this is the necessity for a code of conduct that supports and regulates professional behaviour and ensures public safety and confidence. This code includes recognition that not all nutrition scientists are trained in all aspects of nutrition care, but minimum standards and recognition of scope of practice are crucial.

Nutrition is a multidisciplinary science; outcomes from dietary patterns are intertwined with an individual's physiological and genetic traits. One size does not fit all. Added to this milieu of communication is the problem of those with no evidence-based nutrition training providing advice and using social and other media to guide the public towards inappropriate diets. Those groups and individuals who do not follow a code of ethical practice and are not bound by evidence-based paradigms should be countered by credible, consistent messages that are guided by ethical practice and scientific evidence.

Currently, nutrition science communication suffers from many and varied groups with vested interests who provide a cacophony of noise from which consumers must synthesise the 'truth'. Consumers are confused. Nutrition science needs to regain their trust through consistent and credible communication, in part to counteract the volume and persuasiveness of commercial food advertising.

There is currently no formal accreditation of nutrition science programs in Australia, although the UK Association for Nutrition can accredit international programs. This enables Australian graduates to apply for registration as a nutritionist in the UK and Europe.

To ensure minimum standards of education for nutrition graduates, competencies need to be embedded in the nutrition science curriculum. Low-level competencies (such as knowledge and assessment of evidence) should be included in the education and ongoing training curriculum for all health professionals, including those in the care sector.

There is a clear need for the growth of nutrition professionals in Australia who are capable of delivering on the goals of the decadal plan. Currently, there are several organisations in Australia that register nutrition professionals. There is some overlap in membership of these peak bodies.

- The **Nutrition Society of Australia's** (NSA) registration process is based on educational attainment and practical experience, with plans to strengthen the competency basis of assessment. In 2019 the NSA had 282 registered nutritionists from a total membership of more than 1000 and an additional 38 fellows—members who have made substantial contributions to the scientific study of nutrition and/or its applications.
- The **Dietitians Association of Australia** (DAA) is Australia's peak body for dietitians, with 6900 members and many other dietitians who are not members of their professional body. DAA is involved in the accreditation of all Australian courses, which gives graduates a pathway to becoming an accredited practicing dietitian. Through its board and its members, DAA plays a key advocacy role in promoting the nutritional health of all Australians.
- The UK-based **Association for Nutrition** (AfN) offers international registration credentials; currently there are 12 Australians registered with the AfN and one fellow.

The science of nutrition is not static, but constantly evolving. In contrast to medical models for treatment of a single disease, food (as the vehicle for nutrition) is consumed by all and exists in a complex system from agriculture (dependent on environment) and food processing, to the supermarket, the home and catering industries.

An individual's food choices are influenced by a multiplicity of factors: taste preferences are usually followed by cost, but include other social and economic considerations such as availability, marketing, individual's nutrition knowledge, cooking skills, cultural

and religious beliefs, attitudes and motivations. This requires nutrition professionals to understand a wide scope of nutrition science applications and to be capable of embracing and communicating complexity. Scaffolding of skills, knowledge and development of competence across different areas and levels means that universal adoption of competency-based education is essential.

Any consideration of nutrition education communication should include the following:

- an understanding of the limitations of nutrition research at each level of the food and nutrition system (namely, a laboratory model does not directly translate to a human diet, and associations found in a cohort study of a population may not translate to individualised care. Therefore, while each nutritionist will not necessarily have skills across the whole breadth of the food and nutrition system, they will understand where their work and research fits and the requirement for their roles to recognise and network with other parts of the nutrition professional system.)
- a requirement for knowledge and skills in communication of evidence-based science
- the development of recognised professionalism, including a code of conduct within the nutrition workforce.

A competent workforce will contain individuals whose breadth of expertise will span all aspects of the food chain and who can engage with stakeholders at all levels. While individuals working in nutrition may not deal with all levels (a laboratory scientist will not have to give individual dietary advice, for example), it is crucial that nutrition systems are understood to ensure the science is reflexive and individuals understand their role in the system.

There is a pressing need to educate nutrition scientists with currency of knowledge in newer methodologies that can be applied to nutrition, such as nutrigenomics, bioinformatics, proteomics and so on, to conduct ground-breaking research of the highest quality. The ability to communicate and translate findings into practical solutions is crucial for delivering the decadal plan.

Capacity building must include education in the skills needed for interdisciplinary and multidisciplinary work, such as health economists evaluating outcomes of nutrition intervention, identifying and counteracting societal and commercial drives towards unhealthy diets, and doctors and dietitians trained in interpreting personalised genetic traits and markers. Nutrition scientists who are capable and credible communicators should be nurtured, to enable consumers to make informed decisions on food and nutrition.

In addition to those who may currently identify as nutrition scientists or have all or part of their profession underpinned by nutrition science, other professionals may play a central role in educating the public to improve health literacy and minimise distribution and acceptance of misinformation. Nutrition science professionals have a key role to play in dissemination of nutrition education to other health professionals. This will increase the capacity of the current health workforce to impact the nutritional health of the population.

These professions include:

- medical doctors and dental practitioners
- nurses, midwives, maternal and child health specialists and community care workers
- allied health professionals (including pharmacists, physiotherapists, occupational therapists, speech and language therapists, exercise physiologists, and clinical psychologists)
- early childcare educators and teachers (primary and secondary education)
- technical and further education teachers (such as chefs, personal trainers and allied health assistants).

A plan for nutrition education therefore operates at all levels to disseminate consistent and credible messages that emerge from the national capability for nutrition data—for all Australians.

Structures are required to attract and educate a workforce capable of meeting the many different challenges that a systems approach requires. Workforce competency needs are multifaceted due to the multidisciplinary nature of nutrition as a science and the need for translation into individual behaviour change, alongside whole population shifts in food consumption supported by implementation of supportive policy. By adopting a systems approach to education, Australia can strengthen its own capabilities and position itself to produce nutritionists with the necessary underpinning knowledge and skills and be a leading education provider to the Asia-Pacific region.

THE WAY FORWARD

This decadal plan sets out a strategy for realising the vision that **Australian nutrition science plays a key role in improving long-term health and wellbeing globally, while delivering environmental, social and economic benefits nationally** with core values of equity, sustainability, collaboration and innovation, and three major recommendations of a national research priority, national capability for nutrition data and trusted voice.

The way forward includes developing detailed governance structures and business cases for the establishment and sustainable resourcing of the national capability for nutrition data and trusted voice, and scoping major initiatives consistent with a national research priority.

Extensive consultation with the nutrition community during the development of the decadal plan was crucial in arriving at a common understanding of the challenges and opportunities and in providing a forum for the development of national collaborations across the broad scope of the science of nutrition. Turning this plan from aspiration to operation will similarly involve the concerted action of all major stakeholders in the science of nutrition who share the vision that Australia can—and should—be recognised as a major global player in the discipline.

GLOSSARY

Agrifood	The commercial production of food by farming
Bioinformatics	The interdisciplinary combination of biology, computer science, information engineering, mathematics and statistics to analyse and interpret biological data
Consilience	Agreement between the approaches to a topic of different academic subjects, especially science and the humanities
Dietary pattern	The quantities, proportions, frequency, timing, variety or combination of different foods, drinks and nutrients habitually consumed
Epigenotypes	The heritable patterns of gene expression outside the actual sequence of DNA. Encompasses the specific set of epigenetic marks peculiar to different cells, which determines their fate (i.e. whether they will be brain or bone or adipose tissue, etc.)
Genotypes	The set of gene variations in DNA that is responsible for a particular trait, e.g. gene variations that result in height or eye colour
Nutritech	Technology applications for nutrition and health solutions
Nutrition literacy	The ability to obtain, understand and apply basic nutrition, diet and health information
Nutrition science *and* science of nutrition	The knowledge of relationships between foods, dietary patterns and health at the biological and societal level
Nutrition security	A community's ongoing ability to access a food supply that contains all essential nutrients for good health, not just calories
Omics	A field of study in biology in which the entire complement of molecules is determined, such as genes, proteins or metabolites
Omics technologies	The techniques used to determine the universal detection of genes (genomics), mRNA (transcriptomics), proteins (proteomics), lipidomics (lipids) or metabolites (metabolomics) in a specific biological sample
Phenotype	The physical expression or characteristics of a trait, e.g. tall height or blue/brown eyes
Precision nutrition	The development of more effective nutrition and health solutions by targeting a combination of an individual's genetic, environmental and lifestyle factors
Systems biology	A holistic approach to biological research using computational and mathematical analysis, and modelling of complex biological systems and their interactions

ABBREVIATIONS

AfN	Association for Nutrition www.associationfornutrition.org
ARC	Australian Research Council www.arc.gov.au
CSIRO	Commonwealth Scientific and Industrial Research Organisation www.csiro.au
DAA	Dieticians Association of Australia daa.asn.au
MRFF	Medical Research Future Fund beta.health.gov.au/initiatives-and-programs/medical-research-future-fund
NAFLD	Non-alcoholic fatty liver disease
NHMRC	National Health and Medical Research Council www.nhmrc.gov.au
NSA	Nutrition Society of Australia nsa.asn.au
RCT	Randomised control trial
SDGs	Sustainable Development Goals sustainabledevelopment.un.org
TAFE	Technical and further education
UN	United Nations

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