



High-Value Nutrition Strategic Plan 2019-2024

15 June 2018

Host institution:



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Foreword

The vision for High-Value Nutrition is: 'To grow New Zealand food and beverage export revenue through international leadership in the science of food and health relationships'. Our strategy delivers through building multi-disciplinary teams to create new platforms, capability and collaborations. In so doing, New Zealand builds its reputation as a global leader in the delivery of high-value foods for health through excellent science and research enabling innovation.

As the Challenge enters its second phase, it will build on our science teams from across 16 national and 16 international institutions and bring in new skills and expertise. The Challenge is transforming the research landscape by bringing researchers together who might not otherwise collaborate and has embedded a process of industry interaction that guides research direction to create new pathways to impact and improve consumer health.

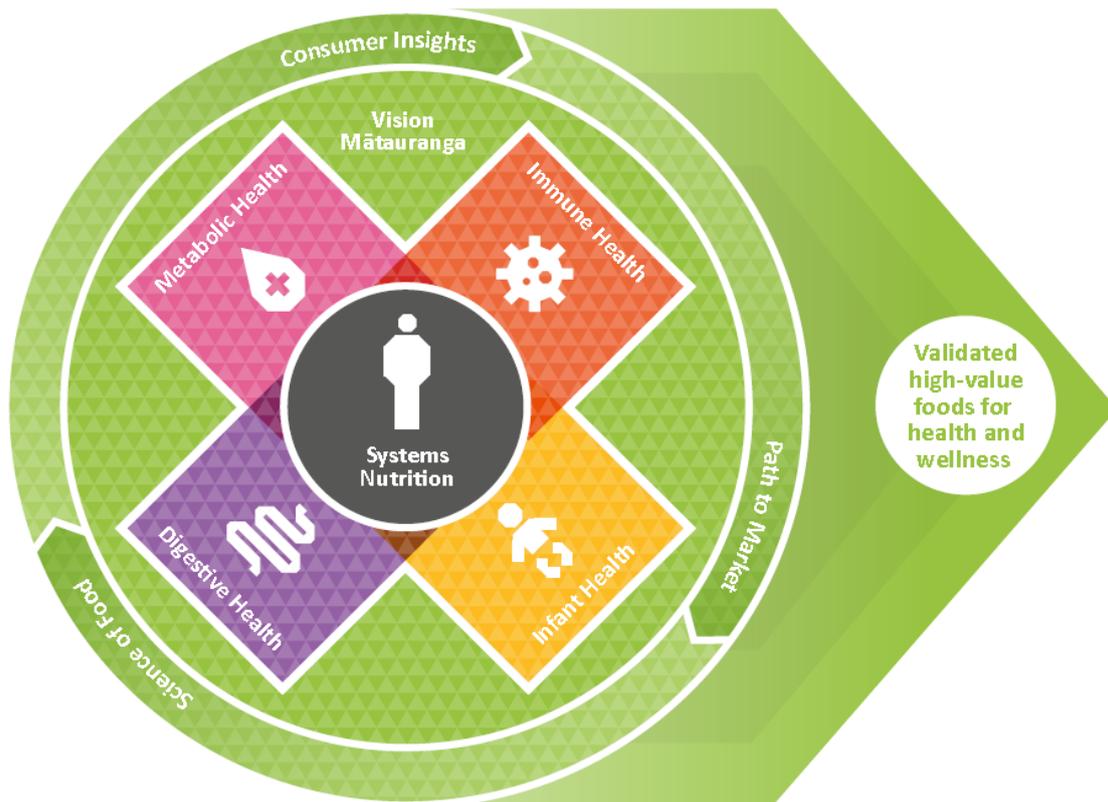
In 2016 there was a significant change in the management team, which led to a refinement of the strategy and increased stakeholder engagement. The appointment of Chief Scientist Professor Martin Kussmann kicked off an evolution of the science strategy that ensures a fully integrated programme under a shared conceptual and practical approach and strong links across the programme that provide additionality. The recent resignation of Professor Kussmann will be an unfortunate loss to the Challenge but the strategy that has been developed - and fully endorsed by all stakeholders means the Challenge is in good stead moving into the next phase, particularly with the recent significant strengthening of the Science Leadership Team.

The Systems Nutrition approach has been translated across all research programmes. This augments traditional science approaches, accelerates the progression of Vision Mātauranga and transforms how our nutrition research is undertaken. Building on the strong foundation of knowledge established in the first phase, in 2019 we will be in a position to undertake multiple clinical trials in the target market, and support businesses with the evidence needed to validate health benefits/claims. Consumers will then be able to make educated and confident choices about what foods to consume to enhance their health and wellbeing, linked to their own needs.

The impact of the Challenge will be seen in increased export revenue, but also in improvements in the health and wellbeing of target consumers. Our focused themes of Metabolic Health, Immune Health, Digestive Health and Infant Health have specific outcomes in areas of high consumer interest.

The conceptual approach aligns strongly with Vision Mātauranga principles of mātauranga and indigenous innovation. Projects arising from the Challenge Vision Mātauranga strategy identify opportunities unique to NZ and relevant globally. The principles have become more strongly embedded in the Challenge in 2017/2018, and will continue to develop. The key stakeholders in this space are Māori owned businesses seeking to increase food and beverage exports with validated food-health relationships. We have established a model of how business clusters can work with High-Value Nutrition, taking a holistic view, combining research, education and commercialisation activities to ensure impact. This will continue into the future.

The diagram below shows how each programme component is integrated into an overall structure with many linkages.



We will build on our overall portfolio, which is a considered and balanced mix of high-risk/high return and closer to market research. Our priority on translational research enables the greatest economic return via industry growth. While focused on our export markets, there will also be opportunities to improve the health and wellbeing of New Zealanders via research collaborations and companies choosing to market high-value foods in NZ. Industry growth will also lead to more employment opportunities, and an increase in the prosperity and health of communities. Challenge researchers are energised by the opportunities for research innovation to grow tomorrow's leaders in nutrition research.

To ensure the science is of excellent quality and remains relevant to businesses, our established advisory panels will have an on-going role in reviewing research proposals, so that sound funding recommendations can be made to the Governance Board. Over 2018, the Board composition will transition to a Board that is made up of fewer members, and entirely independent representatives, with the exception of one from the Host Institution, the University of Auckland.

1. Past Performance

1.1 Overview of progress

The mission of the High-Value Nutrition (HVN) Challenge is to **develop high-value foods with validated health benefits to drive economic growth**. This focus aligns naturally with the Vision Mātauranga principle of Indigenous Innovation. The Challenge has made significant progress, establishing a national programme to help transform the research landscape. Established on the basis of the 10-year strategy, the first funding period focused on new methodologies/biomarkers intended to show the health benefits of foods in targeted areas. Pre-clinical and clinical testing have validated models for the next funding phase to prove the benefits of new or existing foods, in conjunction with industry. The following outlines progress to date.

Additionality and Responsiveness: The Challenge has provided a major and fundamental change in this science area in NZ through bringing diverse teams together to maximise individual capabilities and resources. We have created forums where researchers and industry stakeholders interact, leading to greater mutual understanding of the pipeline of activities required to validate the benefits of high-value foods, and to successfully market these. We have sought opportunities for greater synergies across programme areas, bringing in the overarching approach of 'Systems Nutrition' in 2017. The concept of 'immuno-metabolism' has been applied to acknowledge that many of our targeted health conditions share the common influence of the immune system. We have built in cross-programme activities and biological sample analysis platforms. These have been leveraged into the contestable projects. For example, in the Digestive Health programme the best methods for human plasma metabolomics were established, and then applied across the Metabolic Health and Immune Health programmes and three contestable projects (a2 milk™ for Gut Comfort, Complex Lipids for Enhanced Metabolic Health, MultiProMo). Consumer Insights has shifted to prioritising data collection to support strategy development, and invested in design-thinking led industry workshops so businesses can use insights to assess innovation opportunities, leading to potential impact earlier in the Challenge mission. The refreshed focus on Systems Nutrition, with its holistic approach to science, has the additional advantage of facilitating HVN to work with Māori stakeholders to develop mātauranga - a distinctive body of knowledge at the interface between Indigenous and Western knowledge.

Vision Mātauranga: The principle of Indigenous Innovation drives strategy and has been bolstered by the appointment of a Māori member to the Science Leadership Team (SLT) (Dr Meika Foster [Te Ātiawa, Ngāti Mutunga, Ngāti Rārua]), and establishment of the \$1m 'Tū Ora Metabolic Health' programme which combines science, education and commercialisation. With 25% industry co-funding from NUKU ki te Puku™, the aim is to deliver economic impact with the launch of a product for better glycaemic control in China in 2019. This has enabled Māori Small and Medium Enterprises (SMEs) to leverage the expertise of more established businesses, as well as gain experience in working with HVN science. This is a unique model in NZ, and serves as an exemplar of how multi-party collaboration provides additionality. The strategy reflects the context, where stakeholders are primarily Māori-owned food and beverage (F&B) businesses looking to lift export revenue based on validated food-health relationships. HVN has also continued to identify opportunities for Māori scientists to contribute to research.

Collaboration: A total of 16 science-based organisations nationally are engaged across all of our programmes. Each Priority Research Programme (PRP) has between four and five institutions. The nationwide collaboration reflects our focus on the best teams approach and includes 16 international collaborating parties. This approach has created strong inter-linkages.

The Digestive Health PRP has adopted novel methods to identify biomarkers augmenting national capacity to analyse multi-dimensional data and integrate it with clinical metadata and as noted these

methods have been extended into other PRPs. Programmes are also leveraging aligned research, e.g. Metabolic Health built on research through the MBIE funded Suppressing Diabetes programme, (formerly the New Economy Research Fund, FRST) to underpin an HVN intervention with a novel polyphenol for improved glycaemia. More recently, with the establishment of the Tū Ora programme, we sought expressions of interest for new researchers to join the Metabolic Health theme. This resulted in two new groups joining the Challenge, one of which is led by the Metabolic Health Principal Investigator (PI) from the Healthier Lives NSC, ensuring we continue to build teams with science excellence.

Science Excellence: The process of rigorous review required before funding has continued at key milestones. The review includes evaluation by the international Science Advisory Panel (SAP) of globally esteemed researchers who ensure assessment of quality and novelty against the global landscape. In 2017 and 2018, the SAP visited NZ to review progress and planning. Reports on relative strengths and weaknesses were prepared by the SAP Chair for the Challenge to act upon. Unique to HVN is an Industry Advisory Panel (IAP), which has also reviewed all proposals, progress and plans to ensure relevance to industry, including Māori-owned businesses. Industry Reference Groups (IRGs) for each theme provide on-going input and insight.

- **Metabolic Health:** A Chinese and Caucasian cohort (n=400) has been established in Auckland to identify novel early biomarkers of Type 2 Diabetes in this high risk group, using magnetic resonance imaging (MRI). Two proof-of-principle F&B interventions were conducted on the cohort. Two longer-term clinical studies are underway, one on a high-polyphenol product, and the other on a prototype high-protein/good fat, plant-based product in the Tū Ora project.
- **Immune Health:** Pre-clinical models have been established, and foods tested to assess immune protection against influenza virus or pollution-mediated inflammation. An observational human study (n=122) has been completed in Wellington to understand the impact of the food/microbiota axis on influenza vaccine efficacy. These all provide a basis to move into clinical studies.
- **Digestive Health:** A cohort has been established (n=300, Christchurch) enabling the identification of candidate biomarkers characterising functional gut disorders (FGD) with Irritable Bowel Syndrome (IBS) as the main phenotype. These markers will be used in a proof-of-principle food intervention study in 2018. The cohort has been stratified into four types of FGDs vs healthy controls, so targeted approaches can be used with food products. Our newly developed *Canterbury Food Gut Index* addressed a key resource gap - the lack of a validated questionnaire linking diet to gut symptoms.
- **Infant Health:** A reverse metabolomics approach has identified particular probiotics within the infant gut microbiome that may confer immune benefits, and analysis has determined the prebiotics that would nourish these bacteria. Subsequently, a weaning food has been designed and included in a clinical feasibility study among infants being conducted in 2018.
- **Vision Mātauranga/ Tū Ora:** A collaboration is underway between HVN and NUKU ki te Puku™, a cluster of Māori-owned F&B businesses, to develop a plant based innovative health product (incorporating an indigenous ingredient) which will be tested in a clinical study in 2018, to understand the impact on managing pre-diabetes. This programme is also underpinned by a strong education component.
- **Consumer Insights:** In-depth understanding of consumer needs in the above health areas has been established through in-market interviews and accompanying analysis. Insights have been shared with industry through targeted workshops. We have downloaded social media and online purchasing data for analysis, to further understand the influences driving consumer choices.
- **Science of Food:** A Decision Support Tool has been developed which can be accessed by industry to enable efficient product development of foods containing bioactives. Food systems have been developed to incorporate bioactives into palatable foods for use in the health PRPs, of which one microencapsulation system is being assessed for patentability.

In funded Contestable projects (6/7 also include co-funding by industry), prototype foods have been put through new testing models to evaluate food-health relationships. These are: (a) two clinical studies on a milk showing digestive health benefits (gut comfort) [The a2 milk™ company]; (b) three clinical studies on kiwifruit showing metabolic health benefits (blood glucose modulation) [Zespri®]; (c) three pre-clinical studies on a prototype dairy product evaluating protection from allergy development [Miraka]; (d) development of a prototype product now being clinically tested for metabolic effects and the protection of lean body mass [Goodman Fielder]; (e) development of rapid screening methods to identify the types of Greenshell™ mussels which are rich in known bioactives, and clinical testing to prove bioavailability of the bioactives [Sanford]; (f) a clinical study to understand the metabolic health benefits of grass-fed beef [Firstlight Foods]; (g) *in vitro* models established to understand the optimal fibre-rich foods that are more slowly digested and can be fed to infants to support a good night's sleep.

Other Challenge Highlights:

- Three successful feature events have been held: a science symposium in April 2016 (160 registrants), an industry focused forum in October 2016 (150 registrants), and a two-day combined science and industry conference in September 2017 (over 200 registrants).
- Exceeding the Challenge KPI on industry co-investment (>\$1m), showing the work being undertaken is relevant and useful for businesses.
- Consumer insights workshops held with 57 businesses in the Infant and Digestive Health landscapes; businesses which are now forming an excellent feedback loop for strategic planning. Further workshops are soon to be held on Metabolic Health and Immune Health insights.
- Establishment of 'The Knowledge' – a portal accessible by NZ stakeholders where HVN generated reports, publications and tools can be accessed.
- Strengthened relationships with key stakeholders and end users, primarily NZ F&B businesses. Each PRP has established an IRG, to help guide research and access results and new research models. In total 24 businesses are represented, many of whom attended planning workshops in 2017 alongside key members of the research community. These include Māori groups strongly aligned with HVN, such as Miraka, Anagenix, Wakatū Incorporation, Kono NZ LP, and Ngāi Tahu.

Challenges Faced: It has taken time to build awareness that HVN is a strategic programme aiming to transform the foods-for-health research landscape. As the first NSC established, much communication of the vision behind National Science Challenges and a lot of engagement was required to bring research teams together in the new model. By selecting and engaging with the best individuals and institutes to form the best research teams, there is now excellent national collaboration. It was recognised after the first year of operations that the Challenge would benefit from a new skill set in the management team, and the team was refreshed. This posed the risk of a significant loss of momentum which did occur, with a delayed start of the Infant Health priority programme, and delayed effective integration of Vision Mātauranga. However, once the new team was in place, momentum improved significantly and both these areas are now well established. Other difficulties included unexpected or unsuccessful outcomes - one of the risks of translational and high-risk science. To mitigate risk, Challenge management holds regular reviews with research teams and revises plans, where necessary. Our researchers have also built networks with international collaborators/advisors where development of novel techniques has been a challenge. With appropriate modifications, all programmes continue to meet objectives. With having a clear focus from inception, no strategic trade-offs have had to be made, with decisions made to consolidate programmes together rather than stretch across too many investment areas.

One remaining issue is the ability of the Challenge to measure its economic impact. While export revenue of high-value foods can be tracked through Stats NZ to a certain extent, it remains difficult to relate growth to HVN activities. This is not uncommon across private-public partnerships, and also reflects the time lag between research and impact. We continue to work with PwC to develop innovative methodologies to gather more robust data. This focus will increase in the next funding period particularly as products backed by HVN science enter markets.

Impact and Health Claims: The start of the programme coincided with the implementation of the new Food Standards Australia New Zealand (FSANZ) standard 1.2.7. It was envisaged that industry uptake of health claims would be high, but this has turned out to not be the case. While almost 70 self-substantiated general level health claims have been notified to FSANZ, only three of these were from NZ. A Ministry for Primary Industries (MPI) survey comparing label claims between 2014 and 2016 showed that while nutrient content claims have increased, the number of general level health claims has decreased. When balancing costs/risks/value of a health claim submission, businesses are preferring to communicate science in other ways such as in public relations activities or via healthcare professionals. There is also a significant time lag between conducting clinical research and the submission of a health claim dossier.

Governance: There have been no significant changes to governance or decision-making processes. While there has been some expected turnover of Board and Advisory Panel members, new appointments have ensured a good mixture of required skills and Māori representation has been retained. In 2016 the appointment of a new Directorate team with extensive experience in science and industry has driven the strategic evolution outlined above, and a more extensive, positive engagement with all stakeholders. The Board has continued with self-assessments and have also recognised the desire of MBIE to reduce Board size and remove representative members, this will be incorporated into plans for late 2018.

All of the above activities support the **four focus areas** under which HVN was established:

Clinical application: Our targeted health areas are a high priority to consumers, we have early evidence foods can influence these targets. Proof-of-benefit will increase consumer demand and economic growth. We are in a strong position to undertake clinical trials in the target market.

Biomarkers: We have evaluated 28 biomarkers for use in clinical studies. Some of these build on existing knowledge; the majority provide scientific novelty, e.g., the use of MRI scanning of the pancreas to identify those at risk of developing diabetes.

Meeting consumer preferences and health values: Extensive interviewing of consumers in China has shown clear demand for food products for our targeted health outcomes. By establishing biomarkers and research methods ahead of clinical testing, products with validated health benefits are likely to be in market in the next funding period. Some early outcomes of contestable projects have already been published and used in the public domain to support products, e.g., Zespri® kiwifruit and a2 milk™.

Science of food: We have established a tool to determine ways to protect bioactives through food processing and are developing novel biopolymer systems to further protect bioactives during digestion. We have also built a database of regulatory, intellectual property (IP) and market landscapes, so businesses have ready access to knowledge to assist with compliance for the foods destined for new markets.

These activities are all underpinned by **Vision Mātauranga**, with a strategy to focus on (a) engaging with Māori in the interface between Systems Nutrition and traditional knowledge to develop products that will be attractive to the global market; and (b) leveraging our Tū Ora model of working with Māori across the programmes in a cohesive manner.

1.2 Financial information

The Budget forecast to 30 June 2019 is shown below:

Total Project Forecast 1 January 15 to 30 June 2019				
	NZD	Forecast	Budget	Variance
Revenue		30,050,659	30,047,000	3,659
Total People Costs and Operating Expenses		5,816,067	6,067,000	250,933
Total Research Expenditure		23,881,608	23,950,002	68,394
Total Project Expenditure		29,697,675	30,017,002	319,327
Revenue – Expenditure		352,984	29,998	322,986

Total unspent funding forecast to the end of June 2019 is \$352,984.

The variance in revenue is due to higher than budgeted income from conference registrations. The unspent funding on People Costs and Operating Expenses is largely due to lower than forecast spend on travel related costs. This was in part due to the period when the Directorate was in transition between employees and limited travel was undertaken, and also due to increased efficiencies in planning travel.

Costs relating to governance were less than 2% of expenditure.

Unspent Research Funds is forecast to be \$68,394. This will be held in contingency for the final 12 months of the first funding period, in case additional funding is required to complete the objectives of a particular programme. All research programmes are forecast to spend as per budget.

2. Future Strategy

2.1 Long-term view

The vision for HVN is: 'Growing New Zealand food and beverage export revenue through international leadership in the science of food and health relationships.' HVN will be providing the engine that enables NZ F&B companies to move further along the path from being the trusted suppliers of foods that are safe to eat (which is the dominant current concern of Chinese consumers) to suppliers of foods that are not only safe, but also designed to support sustained good health.

HVN is the engine transforming New Zealand foods from 'safe' to 'safe and good for health'

\$1bn attributable to HVN funded and aligned activity by 2025, with continued growth

NZ in top three global rank as source of innovative foods for health

Food and Beverage products account for 43% of NZ's good and services exports (value \$29bn)¹. However, the vast majority are commodity type products, with \$8bn of revenue being attributed to those which would be considered to be high-value nutrition in 2016². If successful, it is envisaged that an additional \$1bn of export revenue can be attributable to HVN-funded and aligned activities by 2025, following the investment of \$83.8m into the Challenge. This would deliver substantial economic impact, and move food exports up the chain of value-added products. The increased growth would be the start of a trajectory, anticipated to grow over time, as more companies start to invest in HVN activities. We would expect that revenue to be increased by another \$2bn by 2030, and would continue with exponential growth if there is continued investment in the HVN NSC.

According to a baseline survey conducted in 2016 in China, Japan and Australia, NZ currently ranks fourth among nine countries³ evaluated, at being associated with foods for enhancing health or wellbeing⁴. Through the Challenge and related activities, the aspiration is to move NZ to a top three position over a 10-year period, reaching number one within 30 years. This will be achieved by both increased export of foods with validated health benefits and provenance, as well as growing the reputation of NZ as a provider of high-quality science and expertise.

Both the business and scientific landscapes will be transformed over time, with greater collaboration and engagement between business leaders and scientists. In that regard, the field of discovery science will be increasingly aligned to future business and consumer needs. A key challenge is, and will remain, to make long-term translational Systems Nutrition science useful for the short-term R&D horizons of NZ's Small and Medium Enterprise landscape. HVN teams will become established as NZ's primary resource for delivery of expertise, capabilities and clinical data for F&B companies seeking to establish high-value foods in Asia and beyond. Novel know-how and capabilities will remain accessible and continue to grow beyond the Challenge timeframe. The Systems Nutrition approach adopted by HVN, will translate across all research programmes, accelerate the progression of the Vision Mātauranga principles of mātauranga and indigenous innovation thereby identifying opportunities that are unique to NZ and of global relevance, augment traditional science, and help transform how nutrition research is undertaken in NZ. While currently targeting Asian consumers, it is anticipated these methodologies

¹ 2017 Investors Guide NZ Food and Beverage Industry. June 2017. Coriolis, MBIE, NZTE, MPI

² Measuring what counts: 2016 export revenue from high-value foods. PwC, High-Value Nutrition National Science Challenge, July 2017

³ Germany, Switzerland, USA, Japan, China, India, Australia, the Netherlands, New Zealand

⁴ High-Value Nutrition: NZ's reputation for high value quality products that are scientifically validated – the baseline. AERU, March 2017

will be further applied to improve the health of other populations and New Zealanders, particularly Māori, who face similar health issues to those being targeted in Asia.

There will be greater collaboration between businesses, building on the model developed in the first Tranche of funding of clustering SMEs together (e.g. with the NUKU ki te Puku™ group), enabling cross-fertilisation of ideas and sharing of knowledge on innovation and marketing models. We would therefore expect substantial growth in revenue of SMEs. Of the top 100 F&B companies identified in NZ, one-third have an annual revenue of less than \$100m. Through collaboration and participation in HVN activities, we would expect more of these companies to increase revenues above that amount.

Businesses will take a lead from HVN in terms of their ability to use insights and science to understand their own innovation opportunities. In transformation of the F&B industry, they will recognise that translational clinical research can be key to maintaining our reputation as a trusted provider of HVN foods to the world, immaterial of whether data are used in a formal health claim. Companies will realise that they need this information in order to confidently stand behind their products and claims, using a range of strategies to communicate value to the consumer.

2.2 Five-year strategy

2.2.1 How will the Challenge be collaborative and respond to the most important, national-scale issues for New Zealand and the Challenge objective?

Mission and Strategy

High-Value Nutrition has the vision to increase food and beverage export revenue through leadership in the science of food and health relationships. HVN will continue to focus on establishing the national ecosystem that will enable and support businesses to develop and commercialise high-value foods with validated health benefits that target needs identified through consumer insights. This will support the objective of increasing economic growth via increased export of high-value foods, particularly to China.

Consumer Insights identify health issues for urban Chinese consumers

HVN research confirms markers and methods for mechanisms

Markers, methods and foods validated in clinical trials here and in target markets

Systems Nutrition approach integrates disciplines to respond to need for foods that benefit a range of health concerns

Vision Mātauranga embedded throughout Challenge programmes and operations

The mission of HVN is to develop high-value foods with validated health benefits to drive economic growth through research excellence in the following four focus areas:

- Clinical application (what foods do what)
- Biomarkers (measuring impact, clarifying risk)
- Meeting consumer preferences and health values
- Science of food

These are all underpinned by the principles of Vision Mātauranga.

By taking an integrated portfolio approach, each of these focus areas will be addressed in a consolidated way to deliver impact. Starting with the consumer, each health area will continue to address health concerns identified as a priority to consumers, and for which they are likely to invest in high-value foods. Programmes have already identified new candidate biomarkers to measure the impact of foods on health, and will continue to do so as knowledge evolves. We are now moving toward the clinical application phase, where multiple-arm clinical studies will take place in conjunction with industry to validate these food-health relationships. In these clinical studies, novel food products can be tested that have been developed using the latest knowledge of food science, food technologies and processing systems. The seamless integration of all activities will grow the scientific knowledge in NZ, and enable businesses to commercialise new products or develop new marketing messages, leading to increased consumer uptake, and economic impact in NZ.

NZ continues to see strong growth in the F&B sector. Accounting for almost half of total exports, it will be critical to maintain that growth for the benefit of NZ. In the 2018 report⁵ 'Emerging Growth Opportunities in NZ Food and Beverage', the potential for significant growth was noted, in particular outside of the more traditional areas such as lamb and dairy. They identified 51 high growth non-traditional categories with export revenue of more than \$10bn, which provide a solid base for further growth. These can help inform where the greatest investments should be, and could include food products such as premium fruits (cherries, blueberries, and avocados), seafood (whole salmon and seafood extracts), indigenous ingredients, snack bars and beverages, as well as the more traditional high-growth categories such as meat and dairy. By focusing on foods for which NZ has a unique advantage, we will see the greatest impact. However, they may also form the basis for novel food development, by using high quality NZ products to incorporate identified bioactives for maximum benefit.

HVN was established with the 10-year strategy in focus. We have worked on developing science based consumer insights in priority health areas for target consumers. Many of these did not have well established markers of causative mechanisms. Therefore we have built the markers and methods of assessment in Tranche 1, which can now be accessed by F&B companies to validate products, in clinical studies in NZ or in target markets.

Research Programmes

When established, the four health themes (Metabolic Health, Digestive Health, Immune Health and Infant Health) operated as discrete programmes, with targeted outcomes. However, in recent years the establishment of scientific methods and theories in the areas of Systems Nutrition and immuno-metabolism, make it clear that any one health aspect cannot be considered in isolation. In fact, immunity, the metabolome and the microbiome are at the core of many health conditions. Therefore we are evolving the HVN programmes to be much more integrated, leveraging off each other to apply current within programme multi-disciplinary practices across the entire Challenge. This provides additionality across research teams, maximising investment within each programme for a greater outcome.

This is being done at two levels, first by applying the same developed technologies and competencies across health themes. Secondly, the programme will evolve to target what we hypothesize as the 'Chinese Urban Phenotype', which typifies consumers with the same genetic background exposed to a cluster of the same environmental factors in rapidly changing Chinese mega-cities, contributing to

⁵ Emerging Growth Opportunities in New Zealand Food and Beverage. Coriolis, MBIE, NZTE, MPI, 2018.

other organisations such as University of Otago, University of Auckland or industry R&D centres, depending on the specific expertise required.

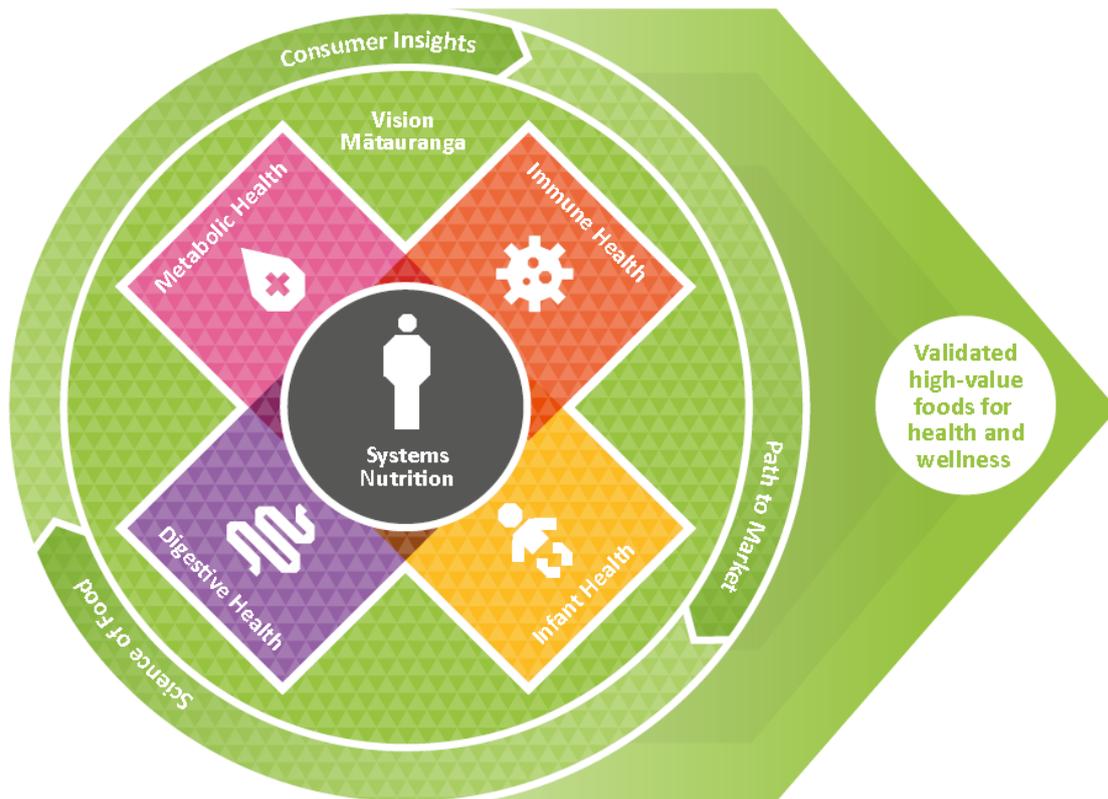
We will have specific programmes for Vision Mātauranga activities with nutritional research activities being undertaken to support the Māori economy. We will support Vision Mātauranga activities across the health themes, and work to increase the capabilities of HVN researchers to operate under the principles of Vision Mātauranga. The programme will also encourage more Māori participation in HVN science and industry, through student scholarships to gain qualifications and work experience while working on HVN projects.

The strategy has been developed in close consultation with our Governance Board, SAP and IAP. In November 2017 a series of workshops were held, each with a focus on one of the HVN health themes, with attendees being a combination of scientists/researchers (68%), and industry participants (29%). The research activities and anticipated outcomes were presented by members of the SLT, and robust discussion gave excellent feedback as to what will deliver the greatest impact. Attendees commented that HVN has evolved to a programme that they see will deliver tangible, relevant outcomes that will meet the objectives of the mission. Some modifications were made to programmes as a result of feedback, such as removing the focus on influenza vaccination efficacy from the Immune Health programme. Input in other areas such as ensuring we understand the consumer demand for high-value foods taking into account views of Traditional Chinese Medicine, and ensuring contestable funded projects can extend the applicability of the PRPs has been taken into account when developing the strategy.

One key piece of feedback was that attendees felt there is greater support needed to bridge the gap between science and industry, including for Māori businesses. Many SMEs do not have the resources or support systems in place to undertake significant consumer research, market assessments, and/or regulatory reviews, or have an understanding how to market scientifically validated health products. In order to address this, the Consumer Insights programme will be complemented by a focus on the 'Path to Market' which will incorporate activities on capacity development for businesses, offering generic workshops, and building on the 'lift and shift' education activities established through Tū Ora - the programme developed with the NUKU ki te Puku™ business cluster to support Vision Mātauranga. By supporting groups of businesses, we anticipate the economic impact will be greater than individual SME businesses operating singularly. We have already started this approach, by facilitating workshops with multiple businesses to share the Consumer Insights work, with businesses also sharing their own knowledge and insights, fostering a shared learning culture and approach to innovation.

We will continue to develop 'The Knowledge', which is a portal accessible by NZ stakeholders that houses the reports and tools being generated for HVN. Over time, this will be expanded to include links to HVN peer-reviewed publications, access to a live IP patent database and links to other tools such as that already developed by the Science of Foods programme.

The programme can therefore be depicted as a fully integrated structure, with Systems Nutrition at the core, creating a virtual hub of capability that can be accessed by all health themes, and other aligned research and NSCs.



Priority Health Programmes

During the establishment of HVN, expert panels convened to conduct foresight planning for the 10+ year horizon. This identified the complex health opportunities that underpin potential consumer led demand for foods with validated health benefits. Four health themes were defined, and the 10 year plans outlined. In order to ensure these health themes remain relevant, we have continued to review available reports outlining key trends and predictions for the F&B industry.

*New Nutrition Business*⁶ provides a yearly analysis, and 10 key trends predicted for 2018 hold great relevance for HVN. These are:

- | | |
|-----------------------------------|---------------------|
| Digestive wellness | Beverages redefined |
| Good carbs – bad carbs | Sugar |
| Plant-based | Fat |
| Protein | Snackification |
| Personalisation and fragmentation | Inflammation |

Mintel⁷ have also identified key trends, with one of these being ‘Science fare’. While primarily focusing on the role of science and technology in enhancing our stretched global food supply, it is clear consumers are becoming more accepting of the use of technologies and science to ensure a secure, safe and effective food supply.

Euromonitor⁸ in its predictions in 2017 included trends of:

⁶ Mellentin J, 10 Key Trends in Food, Nutrition & Health 2018. *New Nutrition Business* 2017;23, no. 2/3

⁷ Mintel: *Global Food and Drink Trends* 2018

⁸ Euromonitor International: *Mega Trends Analysis and its Impact on Innovation*. November 2017

- Experience more – beyond the product, linking experiences to community, authenticity, customisation and engagement all lead to expectations of higher-value foods.
- Healthy living – consumers view health more holistically beyond just physical health. Consumers are moving beyond a focus on convenience, quality and price, to seeking to understand how products will support their values and wellbeing.
- Premiumisation – there is a growing desire or willingness to spend more on products, particularly if they buy time, security and health.

It is evident that the focus on developing high-value foods for the end consumer in the areas of Metabolic Health, Immune Health, Digestive Health and Infant Health are still high priority areas, and will continue to be so in the future, as consumers seek more holistic and natural ways of maintaining health and wellness.

In each of the health themes, the following areas will be of focus:

Metabolic Health – Principal Investigator Prof Sally Poppitt, University of Auckland

The aim of this programme is to identify F&B strategies that can prevent adverse metabolic health, with a primary focus on prevention of type 2 diabetes mellitus (T2DM) in high-risk Chinese consumers. This remains a key concern, with very high awareness as shown in our Consumer Insights interviews. We have found they are acutely aware that metabolic health encompasses the ‘triple highs’ of hypertension, hyperglycemia and hyperlipidemia. Adjustments to dietary and lifestyle behaviours are often the first steps that consumers will undertake to improve the situation, and depending on individual conditions are the first line of treatments recommended by health professionals. However, should these changes not be effective, consumers are more likely to seek medication and alternate methods from health professionals. New products targeting metabolic health would attract the most consumer interest if they had the following:

- Carry obvious health benefits for the individual
- Supported by scientific research
- Provide quality assurances
- Acceptable flavour
- Include detailed information on brands public media platforms.

In the words of the consumers:

“When I visit the doctor for prescriptions for my blood glucose, the doctor will always instruct me that ‘you should eat this or you should eat that’, and I treat these instructions as if it was the imperial edict and try to get whatever is suggested by the doctor”

“...I’m not using any medicine to control my condition right now, I need some good food with additional benefits to keep me in good shape. If it’s natural, then I’m very willing to do that”⁹

In the first Tranche, the Metabolic Health PRP has established a cohort of Auckland-based Chinese adults both with and without the ‘Thin on the Outside, Fat on the Inside’ (TOFI) profile, and a comparator Caucasian cohort. Methods to investigate risk of progression to T2DM using early predictive markers have been developed. The ability to influence these identified markers with foods has also been validated. This programme is in a strong position to proceed to clinical intervention studies in China.

⁹ HVN Consumer Insights Interviews – Metabolic Health, Shanghai, 2-9 September 2017

The focus in Tranche 2 will be to deliver more clinical study evidence of direct value to the NZ F&B export sector through targeted clinical studies in cohorts susceptible to T2DM, in Asia. In addition to this, the science will continue to evolve through developing the Systems Nutrition approach and cross-fertilisation that is central to HVN. Science stretch will continue through entry into new and emerging research areas, for example, interaction of the pre-diabetic Asian metabolome, proteome and epigenome with the microbiome; and determining the cause of the characteristic Chinese metabolome identified in Tranche 1. Phenotyping of Chinese cohorts will also be extended into 'in market' consumers in Asia, to provide the basis for evidence that F&B solutions from NZ will be effective among those with poor metabolic health in pre-diabetic Chinese urban consumers.

The Tū Ora programme implemented in Tranche 1 will be reviewed and potentially evolved to support the growth of Māori owned businesses active in this area. This partnership may be extended to other business/cultural groups, and across PRPs, as a model of enabling growth of business/sectoral clusters.

By the end of 2024, the programme is expected to have delivered a portfolio of data on the affluent 'middle class' Chinese consumer group, both pre-competitive and industry-led. From studies conducted in NZ and China, we expect the research outputs to have made a significant contribution to a range of large businesses and SMEs in NZ's F&B sector, impacting the economy through increased export of high-value foods. However there will still be knowledge gaps, and these will continue to be investigated via HVN having established the national research teams, and developing closer collaboration with other NSCs such as Healthier Lives, networks that can become the primary resource for on-going validation of the metabolic benefits of high-value foods.

Digestive Health – Principal Investigator Prof Nicole Roy, AgResearch

The aim of this programme is to identify F&B strategies to support healthy digestion mechanisms, particularly for those with Functional Gut Disorders, which represent a variation of normal gut function and comfort. These conditions are recognised by some regulators in the context of health claims to allow extrapolation of clinical studies to the general population. In the Consumer Insights interviews, it was shown that consumers pay a lot of attention to digestive health and it can be an area of high priority. They report trying various solutions, yet current products provide no satisfaction. The opportunity for new products that can work effectively on their digestive issues is high:

"They [Doctors] didn't mention any good suggestion or good solution, so all they can say is to eat more fruit, eat more vegetables and drink water, that's exactly what I've been doing but they didn't work very well, and they didn't help to address the root of the problem"

"But you have to have evidence [regarding the claims of gut benefits on the package] but evidence can be false information as well. So, that's why in the end, I will look for a recommendation or, like word of mouth, to actual cases that people have tried it"¹⁰

The focus has been on defining the characteristics that lead to IBS (through the COMFORT cohort), primarily assessing host and microbial biomarkers in a range of biological samples (breath, plasma, urine, faeces) to support subjective measures of gut function and comfort. Now that the cohort has been established, we can continue to build on this and complete ongoing subjective and objective measures to further develop our understanding of this phenotype.

The primary focus will be to build on clinical work from Tranche 1 with the COMFORT cohort and complete dietary intervention studies to prove how F&B solutions can improve gut function and comfort. Based on the mechanistic information derived in Tranche 1, clinical studies will be co-designed with industry partners and across HVN teams. The F&B intervention studies will be

¹⁰ HVN Consumer Insights Interviews, Digestive Health, Shanghai 2-9 September 2017

conducted first in NZ to ensure methodologies are effective, before transferring these into studies in China.

We will also compare biomarker-based systems data from the NZ COMFORT cohort to those from an Asian cohort via collaborations in Asia. This will enable similarities and differences in physiological responses to be pin-pointed and help define the measurement outcomes for F&B clinical studies in-market (e.g. China) in the later part of Tranche 2. When conducted in China, primary end-points will be based on subjective measures of participants gut function and comfort that can be easily implemented in China, and objective measures (biomarkers and mechanistic insights) will be conducted via analysis on samples which are transported back to NZ.

For selected F&B intervention studies, we will integrate host and microbial biomarkers with assessment of functional outcomes of gut function and comfort in real-time measurement of gastrointestinal and brain tissue changes (including using imaging technologies, high-dimensional data integration and mathematical modelling) in human subjects. These studies will further support the development of a portfolio of evidence and knowledge of the mechanisms of action by which a specific food, or an active ingredient in a food, is effective in improving gut comfort and function, by assessing both gut and brain function.

Mining the metagenome and metabolome datasets of the COMFORT cohort with a systems level approach and relevant published data will also generate knowledge on food substrates which are specific to gut function and comfort. This will inform the development of a database of food and biomarker relationships, giving clear direction to industry on appropriate foods to test in clinical studies.

This programme will continue to lead the implementation of metabolomics and microbiome methods into other PRPs as well as integration of multiple high-dimensional (omics) data of host-microbe interactions, necessary for each PRP.

By 2024 and beyond we will be well placed to be internationally recognised as a primary resource for delivery of expertise, capabilities and clinical data to support validation of health benefits of food products for digestive health, also taking into consideration the influence of the brain. Validated and more uniformly applicable biomarkers for IBS will be available, and can form the foundation of future developments beyond the Challenge period.

Immune Health – Principal Investigator Dr Olivier Gasser, Malaghan Institute for Medical Research

The aim of this programme is to identify F&B strategies to support immunological defence mechanisms in the lung. Through our Consumer Insights programme we have reinforced the view this is a key concern for consumers where they state that good immunity means good health. Immunity was related to energy (mental and physical), and that the resistance of your body/high immunity means that you are not likely to get sick:

“Immunity means you are energetic. Immunity means defence against invaders”

“Winter is coming – smog. Harmful for lungs, for the whole immune system”

“I have poor immunity because my white blood cells are low – my colds are triggered by toxic air”

“Air pollution damages my immunity – I cough all the time”¹¹

In Tranche 1, two distinct pathologies have been targeted – influenza virus infection and pollution-mediated inflammation. Studies (including the HVN observational clinical study) have shown that

¹¹ HVN Consumer Insights Interviews, Immune Health, Shanghai, 21-26 October 2017

influenza vaccination history is a significant confounder of vaccine efficacy, and would likely impact nutritional strategies. This could have public health implications regarding vaccination guidelines, and so the work will be further pursued under other funding sources such as from the Health Research Council (HRC). There was also strong industry feedback during planning workshops that products specifically designed to enhance vaccination efficacy would have limited marketing value, and so should not be a priority for HVN.

The next phase will move from pre-clinical models to the design and implementation of multi-arm dietary intervention studies aiming at reducing pollution-driven airway inflammation in the target Chinese market. As part of this, we will also understand some of the mechanisms of efficacy, including quantifying the contribution of the microbiota, and establishing a metabolome signature together with identifying novel immune-active metabolites.

The above information can be used as a resource to build the underlying 'immuno-metabolism' theory of HVN, and applied across all health themes. For example, foods identified as being immune-protective through anti-inflammatory properties could also be tested for impact on gut and metabolic inflammation. This will provide novel capacities to leverage the HVN Systems Nutrition approach and datasets across health themes.

By 2024 progress towards filling current knowledge gaps will have been made regarding how the food/microbiome continuum influences human physiology. In particular how the immune system, which is central to most if not all chronic diseases, can be modulated by small food-derived metabolites. In the post-Challenge period or via other funding sources, this research setting could be extended to other populations, or chronic conditions such as asthma and allergy, which are very relevant in both NZ (especially among Māori and Pacific people) and Asia.

Infant Health – Principal Investigator Prof Martin Kussmann/ Assoc Prof Clare Wall, University of Auckland

The aim of this programme is to prove the impact of complementary foods on infant health, focusing on immunity and a reduced number of infections in early life. When parents were interviewed within our Consumer Insights programme, it was clear that the infant formula contamination scandals are still very fresh in consumers' minds, and food safety concerns are paramount. The majority of those interviewed prefer to purchase products for their infants from outside of China. Once convinced that the foods are safe, they desire that among other benefits the foods primarily contributed to: (i) maintenance of overall health, and (ii) prevention of future illness (immune health).

As summarised from the interviews: *'Chinese parents are willing to spend more money on infant food than on other infant necessities such as clothes, and on their own adult food. The underlying reasons for this particular "generosity" is that babies are seen as the hope of the family.'*¹²

Following on from a feasibility clinical study in Tranche 1, the focus will move to full clinical studies in Tranche 2. We will incorporate learnings around the design of experimental weaning food prototypes, and integration and interpretation of longitudinal, multi-dimensional clinical data with molecular phenotyping data. A full randomised controlled clinical study will first be conducted in NZ, followed by extending the methodologies into clinical studies in China. This will lead to the feasibility of documenting associations, and if possible causality between prebiotic feeding, the growth of immune health-beneficial microbes in the infant gut with reduced number of infections and improved vaccination responses.

¹² HVN Consumer Insights Interviews, Infant Health, Shanghai, 9-16 April 2017

Methods developed in the Infant Health programme will also be leveraged across HVN. The reverse-metabolomics approach developed, which first defines a health benefit and then identifies the probiotics which may confer that benefit, and determines the best prebiotics to feed them, can be extended to all projects with a microbiome dimension. Taking this into consideration, together with metabolomic and microbiomic expertise generated, as well as experience with multi-dimensional data integration and HVN knowledge on immuno-metabolism from other PRPs, we will develop a decision tool on how to deliver health benefits to consumers via nutritional modulation of the gut microbiome in infants. These methodologies will be applicable across health conditions and consumer target groups.

Collaborations with other NSCs such as A Better Start and Healthier Lives could extend the use of these methods and tools to benefit the health of the NZ population. Beyond 2024, we anticipate this approach to be used across populations, and continuing to develop to deliver impact via the food industry.

Programmes that enable delivery of the Challenge Mission

Consumer Insights – Principal Investigator – Dr Roger Harker, Plant and Food Research

The aim of this programme is to identify strategies that will ensure outcomes from research in the Priority Health Programmes can be tailored to meet the everyday needs of the target consumers in China.

In Tranche 1 this involved providing information on consumers’:

- (1) knowledge of relevant health topics
- (2) triggers for changes in awareness of these aspects of health
- (3) impact of illness on lifestyle
- (4) how foods HVN creates will fit into the food culture

For Tranche 2, science will progressively focus on consumers’ choices of HVN foods in the low trust Chinese environment, and how rapidly consumer beliefs, attitudes and perceptions towards HVN foods are changing. Both are critical to the ability of HVN and NZ companies to predict and create foods for the future. In these studies the team will work with the health programme leaders to help identify opportunities to meet consumer product priorities with their science. Equal priority will be given to provision of consumer insights to NZ companies that will enable them to create their own opportunities at the interface between consumer needs and science. As prototype foods are increasingly available from the programme, understanding how to enhance the position of these foods in the minds of consumers as unique to NZ and of high-value will be necessary.

The programme will draw upon methodological excellence across the diverse disciplines represented within the research team: psychology, economics, marketing, human sensory perception and human behaviour. We will deliberately target a high degree of engagement from our industry partners, to help them decipher reports and raw data to identify innovation opportunities. HVN will use consumer insights to guide investment decisions balancing high-risk/high-return and new knowledge generation with incremental research. We will be able to model which projects may provide the best value and potential economic return by targeting those consumers who have a clear need, with a willingness to change behaviours and spend money on a high-value F&B solution.

In the longer term we would expect more businesses to be using consumer insights to develop innovation strategies, as they learn from engagement with HVN. In addition to insights, we anticipate helping to guide businesses in a broader context, utilising subject matter experts to help build the

capacity of businesses to operate in high-value nutrition markets. This may leverage other funding sources/ collaborations such as the CAPEs (Centres of Asia-Pacific Excellence), AgMardt (the Agricultural Marketing and Research and Development Trust), NZTE and the Food Innovation Network.

Science of Food – Principal Investigator Dist Prof Harjinder Singh, Riddet CoRE

The role of the Science of Food programme is to provide strategic scientific guidance and support to develop novel food solutions. The programme will do this using a multi-stream approach, which includes maintaining an awareness of the changing environment to minimise regulatory and commercial risk, working with the health programme teams and industry to ensure they have feasible prototypes for clinical studies, and where necessary developing advanced and potentially novel or proprietary solutions for delivering validated bioactive compounds into target food systems.

The programme will be tightly aligned to the health programmes, and will build on capabilities developed in Tranche 1 and via other funding mechanisms, e.g. Riddet CoRE. The programme will focus on designing and developing foods that have validated health benefits, that consumers want, and that industry can manufacture and take to market. The programme will develop know how and capabilities that will be accessible beyond the HVN Challenge timeframe.

NZ's Reputation for High-Value Food Products – Programme Lead Prof Caroline Saunders, Lincoln University

One of the objectives of HVN is to support and grow NZ's reputation as a producer of high-value foods with validated health benefits. In 2016/17 a survey was undertaken in China, Japan and Australia to establish a baseline measure of NZ's reputation among target consumers. This survey will be repeated in 2019, 2021 and 2023 to measure changes which may occur as a result of increased activity of researchers and NZ businesses in this space. HVN will continue with activities around public participation, building awareness and profile of the Challenge and researchers. It will include activities through media when research is completed and published, and building of international profile through collaborations and peer-reviewed publications.

Measurement of NZ High-Value Food Export Revenues – Programme Lead Dr Bill Kaye-Blake, PwC

The key outcome of HVN is economic impact through increased export of high-value F&Bs with validated health benefits. Tracking this growth has proven problematic, as general sector data does not directly attribute growth to HVN activities, nor measure revenue from discrete high value, nutritional or added-value products. A modified approach is being implemented in 2018, and if seen to provide the data HVN needs, will continue to be measured annually through to 2024. This methodology includes targeted interviews and workshops with businesses involved in HVN, to obtain a detailed understanding of revenues generated by specific products. This can be consolidated to provide an overall view of the impact of HVN.

Vision Mātauranga

HVN derives benefit through Vision Mātauranga via value received by Māori stakeholders from HVN activities, investment in activities that specifically involve Māori and meet Māori needs, and through researchers learning about Te Ao Māori and incorporating learnings into ways of working throughout the Challenge. It is important to note that in the HVN context, Māori stakeholders are primarily Māori-owned F&B businesses aligned with HVN, particularly those that are looking to increase their exports of products that have validated food-health relationships. HVN is also mindful of the impact these businesses have within communities, and growth will lead to increased employment opportunities

and improved prosperity and health among Māori communities. Of the four Vision Mātauranga principles (Taiao, Indigenous Innovation, Hāuora/Oranga, and Mātauranga), the Indigenous Innovation and Mātauranga themes are of particular relevance to the HVN Challenge.

With the Systems Nutrition approach, HVN is well placed to identify, promote and leverage the potential synergies between mātauranga Māori and Western approaches to knowledge. In this respect, we can apply the methodologies employed under each PRP to evaluate the potential for health benefits of indigenous ingredients/foods. This in turn will allow Māori owned businesses to leverage the science developed within HVN. If ownership issues are addressed in line with Wai 262 recommendations, the potential exists to work with Māori across the PRPs in a cohesive manner to develop innovative products based on indigenous plants or other organisms and/or traditional practices.

We will continue to ensure strong Māori voices are present in management, governance and advisory structures, with Māori representation on our Governance Board, IAP and SLT. These members bring in-depth experience of Māori business and cultural perspectives to the Challenge. We also are able to consult on Vision Mātauranga issues and science implementation with a Māori Advisory Panel appointed to the Liggins Institute, University of Auckland. This includes Jenny Rogers who has been appointed to a Kaiārahi role within the Institute. Similarly we will ensure engagement with relevant Māori advisors/advisory groups through our Partner institutions. There are many opportunities for collaborative activities across NSCs in the context of Vision Mātauranga, including shared processes for programme assessment, implementation of scholarships and communicating with communities, and we will work with other Challenges to develop these. Ngā Pae o te Māramatanga – the NZ Māori CoRE also provides an avenue to collaborate along common themes, including the CoRE priority area of Whai Rawa (Māori economy). We will continue to encourage all HVN members, whatever their role, to recognise and accept responsibility for Vision Mātauranga.

The HVN Vision Mātauranga strategy embeds principles across all programmes, and ensures the Māori world-view is guiding all aspects of how we operate. To ensure the direction is aligned with key stakeholders, Māori representatives of the Challenge held a hui in May 2018 to discuss the future activities. This confirmed the view that Māori F&B businesses are the key stakeholders, and the model of clustering businesses together as per the NUKU ki te Puku™ group is likely to have the most impact. There are some key areas that could be explored which are of great interest to Māori businesses, such as marine plants & animals, kumara or alternative proteins based on indigenous/traditional food sources.

The Tū Ora Metabolic Health education and commercialisation programme is being implemented in Tranche 1, and if successful could be extended into Tranche 2. The Tū Ora approach could be rolled out to other projects and/or Māori stakeholder cluster groups. HVN will also learn from this programme, with researchers learning more about Te Ao Māori and incorporating this knowledge into their ways of working.

We will continue to incorporate Vision Mātauranga criteria into contestable application processes, along with assessment procedures and guidelines for applicants. We aim to explicitly support projects where Māori businesses, PhD students and Postdoctoral researchers are involved, and continue to seek out opportunities for other Māori researchers to join the HVN networks. This includes offering scholarships for Māori students to participate in HVN research.

We have identified opportunities for each theme to incorporate Vision Mātauranga, however this is not exhaustive, and will evolve over time. These are:

Metabolic Health – The Tū Ora project will provide a solid model for future engagement with Māori owned businesses. The programme could also be extended by identifying and scientifically validating other unique NZ ingredients, or build further evidence on products already being investigated. Other aligned funding sources could be accessed to evaluate health benefits of products in Māori cohorts using methodologies developed within HVN, where appropriate.

Digestive Health – We will continue to foster the development of a recently appointed Postdoctoral Scientist, Jane Mullaney (Ngāti Porou, Ngāti Raukawa), who is actively working on HVN projects. There will also be multiple opportunities for nutritional strategies to be co-designed with Māori F&B businesses in the field of Digestive Health.

Immune Health – The programme will provide insights into metabolic impacts of foods via the immune system, and thus the health value of unique NZ/ indigenous foods of interest to Māori; opening up the way for Māori F&B businesses to evaluate these, together with HVN in clinical studies. The target area of respiratory health is also highly relevant to Māori populations who have a high prevalence of respiratory disorders, therefore aligned funding sources could also be used to evaluate effects of foods in a Māori cohort using methodologies developed by HVN.

Infant Health – The development of natural weaning products and commercial opportunities that are underpinned by Western systems nutrition is likely to benefit Māori businesses. The selection of kūmara as the intervention product in the Tranche 1 feasibility clinical study offers opportunities for Māori kūmara growers and for the enhancement of traditional knowledge, given the status of kūmara as a traditional food. Other potential options can be explored in Tranche 2.

Consumer Insights – Food products collaboratively developed between HVN and Māori F&B businesses will provide prototypes for anchoring consumer responses to messaging around tikanga (Māori values). To build consumer trust it is important to demonstrate authenticity among NZ consumers, and Māori will be a key part of this, particularly for products which incorporate indigenous ingredients or are based on traditional foods.

Science of Food – This programme is crucial to ensure clinical research findings can be translated into practical food solutions for industry. Focusing on novel or proprietary delivery systems that protect natural components or bioactives, there will be opportunities related to indigenous ingredients or traditional foods.

Programme Integration and Step-Change

The HVN programme will evolve beyond completion of the four individual health themes, i.e. Immune, Metabolic, Digestive and Infant Health. While all these four axes will develop along pre-clinical, pilot clinical trials in NZ, and clinical studies in China, our vision goes beyond that.

The plan is to focus on our series of studies (Immune, Metabolic, and Digestive Health) in adult populations. We can initially mine data from cohorts established in NZ, and then exploit the unique resource that will emanate from our clinical studies on respiratory dysfunction, pre-diabetes and gut disorders in urban populations in China. In Chinese megacities, many adults can be expected to be affected by more than one, or possibly all of these disorders. Our clinical HVN resource and dataset are differentiating and competitive at global science scale, because, to the best of our knowledge, no other consortium is studying these three health phenotypes in a ‘shared environment’ (i.e. Chinese megacities) and on the background of the same ethnicity (i.e. Han Chinese).

We will consolidate a cross-phenotype biomarker set resulting from our three clinical studies on pre-diabetes, gut disorders and risk of respiratory disorders. This biomarker set will then inform the design

and execution of a 'shared environment' study recruiting subjects who represent what we hypothesise as the 'Chinese Urban Phenotype' (CUP), which typifies consumers with the same genetic background exposed to the same environmental factors (stresses) in large cities, leading to multi-factorial problems such as lung, gut and metabolic conditions. HVN is already working on incidence and characteristics of the hypothesised CUP, internally and with our external bioinformatics and systems biology partner(s).

Eventually, such cross-phenotype analysis will allow testing of F&B strategies and solutions that can, if appropriately combined, address multiple risk factors at the same time. We believe this to be scientifically pertinent and economically appealing because consumers want to address their health across different aspects and can well relate to living in a shared environment that affects several health areas at the same time.

As noted in our Consumer Insights interviews:

"I'm having those supplements now, if you've got some food which is good for my health, I don't mind to try them. I'm never going to reject them, I'm totally open to have them together. I'm still going to have this, but if you've got some healthy food I'm going to have that too. So, you can just never have too many things that are good for your health¹³"

Aside from developing capability and knowledge on the CUP strategy, programme integration at conceptual and methodological levels is underway and will continue to be advanced.

The concept of using food to improve mucosal function, as developed and applied in the Immune Health programme, will be leveraged across HVN. Early diagnostics and foods for (metabolic) disease, which are key deliverables in the Metabolic Health programme, will also inform other Challenge research. The Digestive Health programme's work to refine complex and heterogeneous phenotypes by improved quantification of dietary intake; will also have Challenge wide value and impact. The Infant Health programme has demonstrated proof of concept for benefit-driven nutrition research, based on reverse metabolomics compared to the traditional 'feed and bleed' approach and this will be deployed in future Challenge research.

As a methodology, Systems Nutrition remains our overarching scientific principle. The deep and comprehensive molecular phenotyping of subjects enrolled in HVN clinical studies is a key element of all our studies. In the clinical science space, this will facilitate the advancement from "measuring everything in clinical subjects" (discovery research) to "measuring what matters for consumer groups" (translated biomarkers and diagnostics).

The reverse metabolomics approach is an example of how we will enhance data science in New Zealand and with international partners as we leverage the immuno-metabolism aspects across the Challenge research domains, and undertake comprehensive research on the impact of immune cells exposed to food, host and microbe metabolites.

Collaboration in China

With the ambition to conduct multiple clinical studies in China in order to meet business and regulatory requirements, we are now developing a strategy to make this most effective. As many of the health outcomes we are measuring are influenced by the microbiome, background diet and environment are important to take into consideration.

¹³ Consumer Insights Interviews, Immune Health, Shanghai, 21-26 October, 2017

Co-ordinating multiple clinical studies across many sites will become complex, particularly with the cross-programme leverage. By Tranche 2 we will have established solid relationships with the best research institutions in China, so we can have full confidence in the quality of the work undertaken. The role of Principal Investigator (PI) supported by NZ clinical experts as required, will be retained by the NZ based team, to ensure robust science is undertaken that continues to build on knowledge gained in Tranche 1.

We are currently identifying the best research partners, with several options considered. These include the University of Auckland Innovation Institute established in Hangzhou; collaborations with Professor Yang Yuexin, President Chinese Nutrition Society, Director, Department Food Nutrition and Assessment, National Institute of Nutrition and Food Safety; the Shanghai Biological Sciences Institute of Nutritional Sciences; or other academic collaborations identified through current relationships between Challenge researchers, or industry partners. We are also in discussion with members of the Non-Communicable Diseases China Research Collaboration Centre (NCDCRCC) who can help establish links into China. With the recent appointment of Dr Poon Hon Yung to the SAP, we have established a link into other potential research collaborations in China, as he has extensive experience in running clinical studies throughout Asia, and continues to act as a regulatory and clinical study consultant for organisations.

The intent is to overtly seek collaboration (including co-funding where possible) via the established linkages, where a research organisation in China will conduct the clinical studies, under the supervision of a NZ based PI, and a local Co-Principal Investigator (Co-PI). Primary outcome measures will be focused on those key to understanding the effectiveness of the intervention (subjective measures and likely, established biomarkers). Samples will be taken that can be sent back to NZ for analyses using methodologies established in Tranche 1, ensuring we continue to build on and invest in capabilities developed in NZ. We are working with World Courier who have extensive experience in transporting clinical trials samples globally. They have indicated that if samples are of human origin and non-infectious they should be able to enter NZ. World Courier will work with the relevant regulatory authorities in China to ensure samples can be sent out of the country. If this is not possible for all of the different types of samples, we have identified a laboratory in China that would be able to complete some analyses, as they are currently doing this for other NZ funded clinical trials in China, e.g., studies being conducted by the Liggins Institute. It will however be critical assays align with what we have developed in Tranche 1 and are deployed consistently. This may require co-location of key personnel for short periods of time.

There will be substantial risk in conducting clinical studies in China, but we will leverage the collective experience of researchers and industry partners to develop clear policies and guidelines for working in China. This will include training on the cultural aspects of interactions, which will be critical to forming strong partnerships. Some of these cultural aspects are similar to those of the Māori world view, where relationships and a shared vision for mutual respect and understanding are core to business outcomes, and so we have an opportunity to use elements of Vision Mātauranga in establishing trusted partnerships.

While the clinical trials will be conducted in China, there will be benefit for businesses developing products for other markets, particularly in Asia, which have a large Chinese population such as Malaysia (7m), Singapore (4m) and Indonesia (8m). Publication in high quality peer reviewed journals will provide great credibility and support for evidence dossiers for health claims in multiple jurisdictions. The knowledge and capability developed by working in China, will be transferable to other countries/ regions, via the development of a model where NZ based researchers can conduct high quality research in other countries, with IP being retained for NZ and benefits realised through

increased export return of high-value foods. The holistic approach developed by HVN is well suited to this as it will take into account differences in populations and environmental influences.

Sector Alignment

The research portfolio is in alignment with, and helps inform, relevant business and research sector strategies. There is a continued drive within governmental bodies, research institutions and industry to focus on the development of high-value foods. As part of the Food and Beverage Information Project, it was identified that the top 262 F&B firms in NZ have a combined revenue of \$52.7bn (2016), with industry-wide investment driving scale, efficiencies and the continued development of high-value categories¹⁴. Food and beverages form the largest sector of the NZ manufacturing landscape, and business investment into R&D has grown at a CAGR of 5.4% in the eight years to 2016¹⁵, demonstrating on-going commitment to innovation.

The Primary Growth Partnerships (PGP) programmes from MPI have continued to invest in the development of the capabilities required to develop high-value foods. For example, in 2016/17 there was completion of the Whai Hua PGP, led by Wairarapa Moana ki Pouakani Incorporation, Miraka Ltd and Kanematsu NZ Ltd, which developed and launched dairy wellness products for health conscious consumers in NZ and Asia. The Omega Lamb PGP in partnership with Alliance Group and Headwaters NZ resulted in market trials of premium lamb with claims validated on the omega-3 content of high value lamb cuts, which showed that TE MANA LAMB can achieve a significant premium over standard NZ lamb. There are several other PGP programmes which align with HVN, including those with Fonterra, ANZCO Foods, Spring Sheep New Zealand and Sanford Ltd. On-going current and possible future investments within the PGP programmes will continue to grow the value-add sector.

Strategic Science Investment Funding (SSIF) within Crown Research Institutes aligns with HVN. In 2017/2018 \$3.8m was invested by AgResearch in programmes relating to Added Value Foods, Food Nutrition and Unlocking Value from Whole Carcass. There was also industry co-funding from eight NZ businesses to these programmes. AgResearch have noted that HVN Challenge research is influencing the direction of the projects by providing some overarching science direction that ensures the science plans are complementary, but distinct from the HVN Priority Research Programmes. Similarly, Plant and Food Research have used funds from SSIF, MBIE, HRC and direct investment into \$2.1m of activities aligned with HVN in 2017/2018, some of which also includes industry co-investment. These investments extend the knowledge gained by HVN in the areas of consumer insights, metabolic health, gut health, immune health and food bioactives.

Alignment of other investments complementary to HVN include the MBIE Endeavour funded 'Smarter Lives' programme in 2017 which, together with industry partner Fonterra Co-operative Ltd investigates pre-clinically how foods influence brain function via the sophisticated communication systems between the gut and the brain, with more than \$12m earmarked for the research. In addition the Faculty of Engineering at the University of Auckland was granted \$945,000 of Marsden funding in 2017 to understand why texturally complex foods lead us to eat less, which aligns with the HVN Metabolic Health programme, given obesity is a significant risk factor for the development of T2DM.

HVN has been engaging with MBIE representatives on the 'Future Foods' projects, which are evaluating NZ's position on the increasing demand for alternative proteins. While not a key area of focus for HVN science, foods that are developed may have particular health benefits, and so HVN capabilities may be required to help prove those benefits. In addition, there is scope for development

¹⁴ 2017 Investors Guide NZ Food and Beverage Industry. June 2017. Coriolis, MBIE, NZTE, MPI

¹⁵ Beyond commodities: Manufacturing into the Future. 2018. MBIE

of alternative protein sources that leverage biodiversity and indigenous bioactives/ingredients/foods and increasing consumer demand for natural products. In that scenario, the science and industry interface developed within HVN could be pertinent for Future Foods. We will continue to engage with teams on this aligned work.

It is clear that the portfolio of research within HVN is well aligned with, and influencing other sector investments and strategies, and will result in an integrated national approach to research investments. We will continue to work with partner institutions on determining how future projects will best align with HVN. Outcomes of other programmes on fundamental research and product development will dovetail well into the clinical, consumer insight and science of food capabilities developed by HVN.

Globally Building on Research

The strategy developed by HVN builds a unique programme in NZ, and is well placed to build on other relevant NZ and international research. There is also potential to collaborate with other consortia. In 2017 the Infant Health team submitted a European Union Joint Programming Initiative (EU JPI) 'Healthy Diet for Healthy Lives' proposal, which was very positively evaluated at Expressions of Interest stage, but was unfortunately not funded in the final round. Through this we have however, identified an excellent group of EU-based 'omics' and nutrition competence centres with whom we could collaborate further under future EU calls.

There are a number of other funding sources HVN or aligned researchers could attract to build on the mission of HVN. By establishing research relationships with collaborators in China, researchers could apply for further funding under programmes such as the HRC NZ-China Non-Communicable Diseases Collaborative Research grants.

HVN will continue to evaluate national and international opportunities to align with, and for researchers to access funding from, that will contribute to the mission.

2.2.2 How will the Challenge ensure the research, science, and technology will be excellent quality?

Best Research Teams

We have established a very strong and experienced research team in Tranche 1, while also developing early to mid-career researchers. We will continue with our established science team leaders, while also bringing in relevant new researchers that can bring new skills to Tranche 2. We recognise the best team must be comprised of individuals who bring valuable knowledge and skills to the Challenge, but who also support a collaborative approach. People may join via specialist contributions to a theme programme, but we will also seek those who can take a cross-programme approach, particularly for data integration.

Building best teams for today and tomorrow

International collaboration, benchmarking and advice

Prime criteria for investment is alignment to mission

We intend to retain a focus on growing tomorrow's leaders, through inclusion of PhD students, post-doc researchers and early career researchers. In Tranche 1 we established national networks through holding a series of webinars specifically for the early career HVN researchers, so they could connect

with each other and communicate on topics of common interest. These were hosted by members of the SLT, who helped to facilitate introductions and discussion. These have proven to be of great benefit in building relationships across HVN, so the emerging researchers have a national forum to share learnings and challenges. We will continue this in Tranche 2 with on-going building of the HVN community, where we can improve scientific activities through shared learning.

We will seek to build greater capability among Māori researchers by promoting inclusion into Challenge teams, and mentoring and supporting them to develop their career. By embedding the principles of Vision Mātauranga across all teams, we will create an environment in which the needs of Māori researchers are recognised and well supported.

Science Advisory Panel

During the establishment of HVN, we built and have since engaged with an international SAP on an ongoing basis. They have reviewed all funding applications, and provided constructive feedback and recommendations on these. With annual visits to NZ, we have developed trusted relationships and the forum for robust discussion on science plans. As we enter the next phase of funding we have reviewed the skills and capabilities required to provide the best advice to HVN, and have reconfigured membership as necessary.

The current members are:

- Professor Sean Strain, Emeritus Professor of Human Nutrition, University of Ulster, Ireland.
- Professor Philip Calder, Professor of Nutritional Immunology, University of Southampton, England.
- Professor Nancy Krebs, Professor of Paediatrics, University of Colorado, USA.
- Dr Poon Hon Yung, Independent Consultant, Hong Kong

We are currently seeking additional members with expertise in the microbiome and Systems Nutrition space. It is recognised that the area of Consumer Insights is outside the expertise of current members; to date individuals with this expertise have been utilised on a one-off basis to review relevant proposals, to ensure the quality is assessed. This approach will continue into the next phase.

In April 2018, a 3-day meeting was held with the SAP, for an in-depth review of progress and plans, and to obtain an assessment of how the programme fits within the international landscape. They reviewed and endorsed the changes to science strategy. Following the meeting and a report from the Chair of the SAP, the programme plans have been adjusted to take into account their advice. Discussion was at the level of the programme outline, and SAP members expressed a strong willingness to provide further input into protocol design as we develop the plans for clinical studies. Some SAP members have been involved in clinical trials in Asia, and so have valuable advice to ensure we minimise risks and have the appropriate processes in place.

As HVN is building on science being developed in Tranche 1, we will continue to ensure best research team collaboration by releasing a Call for Participation in 2018, for additional researchers to join the teams. Applicants who have skills or capabilities that can complement and enrich programme objectives and activities will be invited to facilitated workshops that will lead to consolidation of research teams, and the development of research programme proposals that are of the highest calibre. As the scientific activities move to a new phase, we anticipate changes to the teams involved in each programme.

International collaborators

We have already established solid linkages with international researchers, who have freely provided advice and input into our programmes. In total we have 16 international partnerships. We will continue to grow these relationships, as well as seek additional collaborators as the programme evolves. We have developed linkages into COSBI (The Microsoft Research – University of Trento Centre for Computational and Systems Biology, Italy), who have capabilities that will be important for integrating all the programme data in the next phase. While there is emerging capability in NZ, we will continue with this relationship, and seek to enhance capability into NZ, either by placing key NZ researchers into training positions at the Centre, or by bringing people to NZ to augment capability developed here.

Contestable funding

Building on the success of contestable funded projects in Tranche 1, we will continue to seek applications for contestable funding in Tranche 2. However the proportion of funding allocated will change, moving from 60/40 PRP/contestable, to a 70/30 split. We will be very clear that any contestable funding applications must align to and support one or more of our four health themes, address Vision Mātauranga, and have a clear path to industry impact.

The amount of each fund awarded will vary, with a mixture of seed (small), medium and larger projects. The larger projects will be closer to market impact, with the smaller ones helping researchers/ businesses to establish evidence at an earlier stage, which may be a mixture of pre-clinical and clinical research, or insight development. These will continue to bring in new ideas and researchers into the Challenge, and by aligning with a health theme, aim to provide additional impact to the PRP activities and vice-versa. In this light, we will identify through consultation with the NZ F&B and research communities, a set of topics that would be of particular interest to add to the programmes, but not limiting ideas in contestable projects to those we already have.

A robust process will be put in place to assess applications, including review by the SAP, IAP, SLT and Challenge Management, bringing in subject matter experts as required. In order to ensure continued complementary, enrichment and refresh of activities, we anticipate holding two funding rounds – in 2019 and 2021. This will allow sufficient time for projects to develop significant outputs. All conflicts of interest will be managed according to the HVN Conflicts of Interest policy, which has worked well to date.

2.2.3 How will the Challenge focus on delivering impact?

Economic Return on Investment

HVN is tasked with investing in activities that will contribute to an increased export revenue of an additional \$1bn over the 2015 baseline. To achieve this, there will be investment into HVN capabilities using both Challenge funding, as well as funding from other sources such as from industry or other government grants. In addition investment into the wider support systems will be required to achieve economic growth. Success will also be reliant

Business estimates of 20% revenue rise with foods with validated health benefits

Strong commercial focus on decisions

Partner with NZ-China focussed organisations and research partnerships

on aligned and related research investments from other sources such as SSIF funding into the validation of health benefits of foods, building the national ecosystem to achieve the goals. Critical to this will be HVN supporting and engaging with businesses investing in and marketing high-value foods.

In Tranche 1, business cases were submitted by those applying for contestable funds. These are highly optimistic forecasts and cannot all be directly attributed to HVN. It does however reflect the confidence businesses have in validating and marketing the health benefits of high-value foods. We are currently working through processes with PwC as part of their existing contractual obligations to HVN to more accurately quantify the return on investment. This will be completed via company interviews and workshops to develop a formula to measure impact. We will also develop mechanisms that will ensure businesses benefiting from HVN funded research have more accountability to report on return on investment in the future.

The final target of \$1bn additional export revenue in 2024 as a result of investment in HVN and aligned research will require further frameworks to enable accurate measurement. As we continue to get a deeper understanding of the wider research landscape we will develop the mechanisms to measure the economic return.

Industry Engagement

The success of HVN is reliant on strong engagement with industry, including Māori industry, particularly those F&B companies seeking to grow their business through increased export of high-value foods. These businesses will have the commitment to develop and test foods within clinical studies that are managed by HVN, with some co-funding required to ensure true commitment to market these foods using the science outputs. HVN has been building engagement through a series of activities, which will continue in the next phase. For example:

- Appointment of an IAP of experienced business leaders to help guide and shape HVN activities.
- Each programme area has an IRG that helps guide programme developments, and where appropriate provide products for testing in pre-clinical and clinical models.
- An industry focused forum in 2016, with over 120 attendees, a combined industry and science conference in 2017 with over 200 registrants, and another conference planned for 2019.
- Individual company meetings between programme leaders and/or the HVN Directorate, to evaluate opportunities aligned to particular businesses.
- Regular communication through newsletters, and engagement through workshops, e.g., the Consumer Insights workshops
- A specific page on the HVN website 'The Knowledge' – a password protected site where businesses and researchers can access HVN reports, links to HVN generated peer-reviewed publications, and other tools such as a live IP patent database and the product development decision support tool generated by the Science of Food programme.

Industry Advisory Panel

The Industry Advisory Panel will continue to review all funding proposals, to determine if they will deliver outcomes likely to be of relevance to industry. The role of the IAP is to act as strategic advisors on all areas of the HVN programme, as well as to facilitate the development of industry networks. The current members of the IAP are:

- Dr Kevin Marshall – Director cDNAk (Chair)
- Dr Jeremy Hill – Chief Science and Technology Officer, Fonterra Co-operative Ltd
- Craig Armstrong – Director, NZ Trade and Enterprise
- Richard Te Hurinui Jones (Ngāti Maniapoto, Te Arawa), Chief Executive, Poutama Trust
- Ronnie Butt – New Business Development Manager, Comvita
- Sarita Males – Chief Technology Officer, Douglas Nutrition
- Gerard Hickey – Managing Director, Firstlight Foods
- Steve Hathaway – Director, MPI (observer)

In 2018 we commenced an exercise to determine what are the necessary skills for members of the IAP to be of maximum benefit in Tranche 2, and are currently undertaking a self-assessment against those. This may result in the rotation of some members, or addition of new experts.

The draft list of skills is:

- Consumer insights
- Digital capability (research, sharing knowledge, export)
- Route to market/commercialisation
- China and emerging markets
- International collaboration/networks
- Research management/R&D
- Regulatory
- Translation of research outcomes for industry
- Wide view of industry needs to guide science
- Vision Mātauranga
- Product development

The inclusion of a member from MPI has proven beneficial for HVN to have regular engagement and gain an understanding of governmental activities that may influence the industry. It also provides an avenue via HVN for businesses to work with MPI to understand the requirements for, and methods for preparation of, dossiers in support of health claims.

Industry Reference Groups

Each PRP has established an Industry Reference Group of interested parties who are likely to use HVN capabilities in the future. Across the programmes we have 24 companies participating, four of which have Māori links/ownership. Engagement has been through two formal meetings per programme annually, in which HVN has shared research results to date, and received advice from members on what is seen to be of most relevance for the future. This has also led to individual interactions between IRG members and the PI, and in some instances separate investment in aligned activities. The role of the IRG could be described as being more tactical versus the IAP, the latter having oversight and providing guidance on all HVN activities, whereas the IRGs are more closely connected to the detail of the research programmes, and are likely to be end users of the science.

As we are evolving the programme to one which is much more integrated, we will also work through the possibility of combining the IRGs into one programme wide group. This would provide more opportunities for them to obtain an appreciation of the cross-Challenge linkages and prospects. We will also ensure there are those businesses participating which have the greatest commitment to investing in/using HVN capabilities. It will correspondingly provide a better mechanism for the enabling programmes of Consumer Insights and Science of Food to be embedded into the health programme discussions that are occurring with businesses, further demonstrating the importance of

taking into account consumer need, and the ability to develop suitable products, as well as the health science.

Communication and Collaboration

Through these engagements and industry presence at a series of workshops held in late 2017, we are confident that the focus of the health themes is still highly relevant to industry, and uptake of science will not only be achieved but widely supported. We will however, work with a wider variety of organisations and key experts to ensure that businesses have the support and knowledge needed to succeed in the high-value nutrition market internationally, as this was identified as a clear need.

For example, we have identified a number of other collaborations throughout NZ that HVN can align with to help support businesses. These include the Centres for Asia Pacific Excellence (CAPEs), and the New Zealand Contemporary China Research Centre. The CAPEs are committed to enhancing New Zealand's economic engagement and cultural understanding with the Asia-Pacific region, and building New Zealanders' understanding and ability to engage. They offer events, programmes, scholarships, internships, and other initiatives to support NZ's businesses, schools, communities and students to understand the key countries of the Asia-Pacific region better. They are enthusiastic about potential alignment of activities, and also offer intercultural training which could benefit NZ researchers and businesses engaging in China.

The Contemporary China Research Centre is a multi-university program based at Victoria University, with activities facilitating business-related research on China, organising national and regional symposia on marketing and business management relating to China, and engaging with the NZ business community to promote trading relations with China. HVN will further build on these connections, to determine how we can best leverage activities for businesses involved with HVN. Other organisations such as NZTE, Export NZ and the NZ China Council will also provide avenues for collaboration and facilitation of engagement with relevant businesses.

Working with the business cluster of NUKU ki te Puku™ has proven successful to date. This unique model of businesses combining to develop and launch a product with clinical validation in China could be extended in the next Tranche. We will work with organisations such as NZTE and Callaghan Innovation to identify other potential cluster collaborations, which are highly likely to be among Māori businesses operating in similar sectors. Critical to this, HVN has clear IP management processes in place, which will continue to evolve as we develop engagement models with businesses/groups.

The intent of offering smaller sized contestable funded projects, compared to those funded in Tranche 1, is to support greater access to HVN by SMEs who are likely to have fewer resources available to co-fund projects. We are also planning workshops which will involve a wide variety of businesses, to help map the innovation journey to impact. This will create a series of templates that businesses can use to understand how and when to engage with HVN, and then how to successfully use research/science in their business. This will greatly extend the knowledge and capabilities across NZ F&B businesses, with the support of HVN networks.

Collaboration may also include working with the Science for Technological Innovation (SfTI) NSC, as they are proposing a Spearhead project on the Personalised Value Chain – to enable the use of technology to better link NZ's exporters with global consumers. HVN is establishing consumer insights on purchasing behaviour and influencers of this, which could directly inform this development, and in return end users of the technology will be HVN industry stakeholders. We will continue to engage with the other NSCs, in particular the health Challenges Ageing Well, A Better Start and Healthier Lives to determine if there are other collaboration opportunities.

We are planning another combined industry-science conference in April 2019, to drive awareness and share outputs of the science achievements from Tranche 1. This will be a key opportunity to hone in on those businesses who are likely to participate by providing products or co-funding for clinical trials in Tranche 2. Deeper connections will be formed that will lead to products with validated health benefits being ready for export. We will also continue to seek specific engagement with relevant Māori stakeholder groups with an interest in high-value nutrition, utilising existing networks aligned with HVN where possible.

Product Selections for Clinical Studies.

When the initial proof-of-principle pre-clinical and clinical trials were started in Tranche 1, it was identified that a mechanism to select the most appropriate foods/beverages to be tested was required. In 2017 a matrix was developed to take into account the most relevant factors for product selection. These included the following criteria:

- Able to be formulated into a suitable/stable product
- Suitable consumer value proposition
- Effective dose available and realistic cost
- Potential to grow, isolate, formulate or process in NZ at appropriate scale
- Route to commercialisation identified
- Previous evidence on potential proof of benefit
- NZ provenance, building on NZ brand and reputation
- IP opportunities
- Regulatory permissibility
- Vision Mātauranga links

A scoring system was developed to objectively determine what would be the best selections, particularly for Tranche 2. This system does however tend to steer selections towards foods produced by larger scale businesses. As we move towards full randomised controlled studies, it is important that HVN provides benefit across sectors and different sized businesses. We will therefore develop criteria in addition to the above to ensure that across HVN we have a mix of products tested across horticultural/ dairy/ seafood/ meat sectors, as well as those from a balance of large and SMEs. This decision making tool was identified as being critical by both the SAP and IAP to increase the impact and success of clinical studies and market launches.

Relevant Science

In order to deliver impact, we need to ensure the science remains, or becomes of increasing relevance to target consumers. The health areas of focus have been recently revalidated, using available reports and our own Consumer Insights interviews. However we need to ensure ongoing assessment of consumers' needs will continue in the next Tranche. If necessary, scientific methodologies within the health themes will evolve to address any changes in consumer priorities. The Consumer Insights programme will repeat some interviews in the later phases of Tranche 2, to get an understanding of how consumer needs/behaviours are evolving over time, which will give a good indication of how these may further change in the longer term.

Regulatory

The impact of marketing foods with health benefits/health claims will be dependent on regulations, many of which continue to change, particularly in China. We will maintain our close relationship with

MPI/ FSANZ to understand the wider environment, and provide support to businesses on what the requirements for them will be. The series of Scanning the Horizon reports will continue to be developed through the Science of Food programme, which provide regular updates on global regulatory changes of relevance.

Meeting Māori Needs/ Vision Mātauranga

As noted, the primary Māori stakeholders for HVN are F&B businesses. By evaluating the success of the Tū Ora programme and collaboration with the NUKU ki te Puku™ business cluster, we can understand how to extend the model to other businesses. With very experienced and respected Māori business owners in our governance and advisory groups, we can leverage knowledge and networks to identify and work with other sector collaborations; those identified as being of particular interest to Māori include the marine animals and plants, kūmara, and alternative protein industries, however we will not limit activities to these sectors.

HVN acknowledge the activity happening across NZ exploring and cataloguing taonga species and associated mātauranga Māori. HVN will explore these initiatives further, with the intent of developing a strategy to most appropriately support Māori businesses to maximise traditional knowledge of the potential health effects of indigenous or traditional foods, by combining it with our Western Systems Nutrition approach which takes a holistic view. This will enable the culturally appropriate ways of developing high-value foods using mātauranga Māori, and create a compelling consumer value proposition.

In addition to indigenous innovation and mātauranga, it is recognised that the principles of hauora and taiao will be indirectly enhanced by the success of HVN. For example, many Māori businesses are based in the regional areas of NZ, areas which tend to have higher levels of unemployment or poor health outcomes. By growing the businesses in these regions, there will be many opportunities for employment and improved health. The recent launch of Miro – a business owned by 20 Māori trusts, iwi and collectives in a joint venture with Plant and Food Research, aims to significantly and sustainably grow the berry fruit industry by focusing on new and existing blueberry varieties for NZ and export. They believe over nine years the company can scale up to 5000 jobs. As outlined by Miro chair Rukumoana Schaafhausen “We came together because we wanted jobs for our people, higher returns on our land, and to own IP and a global business that would secure a future for our mokopuna”.

Many Māori businesses are whānau or family collaborations, and as well as having economic goals, they are also largely driven by social, cultural, and environmental objectives. These are the values that HVN will operate under, and we will prioritise outreach to regional areas, creating opportunities for Māori businesses that can then translate back to improving the health and prosperity of the Māori population.

HVN also recognises that education continues to be critical for the success of Māori. There are two avenues that HVN will take to promote our education objectives. Firstly, encouraging more Māori participation in nutritional science, by offering scholarships for Māori students to work within HVN research areas with defined career pathway and leadership opportunities. There is a significant opportunity for a co-ordinated approach to offering scholarships across all NSCs, building Māori capability in the scientific areas of most importance to NZ. Secondly, we will continue to support the ‘lift and shift’ type of education programme being implemented in Tū Ora, using the collective knowledge and experience of diverse businesses working together to address the knowledge gap that currently inhibits Māori businesses from engaging in science, technology, high growth IP development

and commercialisation. This is a two-way knowledge exchange between science and Māori businesses, creating an opportunity for mutual development.

2.2.4 How will the Challenge ensure decision-making and accountability arrangements are sound and enduring?

Governance

HVN has been operating a Governance Board that comprises nine members, of which five are representatives of Challenge parties, and four (including the Chair) are independent members. HVN has a clear Conflicts of Interests policy which is strictly implemented, so that Challenge Party representatives do not vote on or influence proposals that will direct funds towards their institution.

Embedded reviews to ensure right governance and advisory skill and knowledge mix

Robust and transparent decision-making

KPIs reflect Challenge evolution

Current Board members are:

- Bob Major (Chair - Independent)
- Professor Jim Metson (University of Auckland – Host institution)
- Dr Rodney Wong (Massey University)
- Dr Jolon Dyer (AgResearch)
- Dr Jocelyn Eason (Plant and Food Research)
- Professor Richard Blaikie (University of Otago)
- Jane Lancaster MNZM (Independent)
- Dr Andrew Kelly (Independent)
- Paul Morgan [Ngāti Rārua and Te Māhurehure] (Independent)

HVN are confident that the Board has been operating in the best interests of the Challenge, and that is reflected in the strategic evolution and self-assessments conducted. However, there have been concerns raised by MBIE about the large size of the group, and perceptions of possible impartiality by having Party representative members. MBIE prefer a governance model that is purely skills based rather than the current mixture of skills based representative and independent members.

The Board was established using a matrix of skills thought to be necessary to effectively govern the Challenge. These were:

- Clinical nutrition
- Public health
- Research ethics
- Food regulations
- Food export and marketing
- Research strategy, management and performance
- Science of nutrition and health
- NZ food sectors

- Māori engagement
- Governance and risk management

Over the last two years the Governance group have continuously reflected on what are the necessary skills required to effectively govern and take the Challenge forward, and to assess performance against those. We are confident that we have had the rights skills in this phase, as shown by the heat map below against the refreshed matrix:

Governance
Research Management - Commercial
Product Development
International Networks - Commercial R&D
Research Management - Academic
International Networks - Academic
International Markets
Asian Markets, particularly China
Scientific Expertise - Nutrition
Regulatory
Scientific Expertise - Health
Vision Mātauranga

However the Board has made the decision that for Tranche 2 they will move to a smaller sized Board (five to seven members), that comprises entirely of independent members, with the exception of a representative of the Host Institution who will have voting rights. Appointments will be based on having a good representation of the above skills.

We intend to transition to the new Board by December 2018, so that it is in place to approve funding proposals for Tranche 2 in early 2019. The current Chair Bob Major will continue until June 2019 to ensure there is continuity and reduced risk of disruption to processes/ decision making. This has been discussed with all Challenge Parties, and while there has been some disappointment at the disbanding of a well-functioning Board, there is understanding that this is the most appropriate direction to take. It will require amendment of the current Collaboration Agreement between Challenge Parties, which will occur before the new Board is appointed in 2018. As per the current agreement, in the future the Chair will be appointed upon mutual agreement of all Parties, with other members approved by the Chair, and appointed by the Vice Chancellor of the Host Institution.

Challenge Parties

All five Challenge Parties will remain with HVN in Tranche 2. They have all agreed that HVN is performing well, and they see value in remaining a Party to HVN. With the change to Governance arrangements, a mechanism will be put in place to ensure appropriate communications are given to, and received from, Challenge Parties. This will be managed by the Directorate, with communications coming from the Board Chair or Host Institution representative as needed.

We are in discussion with two other possible Parties which are interested in joining the Challenge. These are the Malaghan Institute of Medical Research, and Victoria University. The Immune Health programme is being led out of the Malaghan Institute, which has been highly supportive of HVN, and has committed significant investment to a number of technology areas that will greatly support and contribute to HVN science in the future. Victoria University has a number of areas that align to HVN, including Consumer Science, the Ferrier Institute, the China Contemporary Research Centre and

technology development. If there is mutual benefit and value in these institutions joining as a Challenge Party, the Collaboration Agreement will be updated to reflect this for Tranche 2.

Decision-making Processes

As outlined throughout this document, all funding approvals have, and will, go through a robust process before approval. This includes:

- Bringing the best research teams together by a process that involves Calls for Participation to join research teams, followed by workshops to identify the additional skills/knowledge/capability that researchers can bring to the programme – and those who are willing to operate in the nationally collaborative model.
- Research funding proposals are reviewed by the SAP, IAP and members of the SLT who are not involved in the programme, as well as the HVN Directorate.
- Where we may not have the required scientific depth within the SAP in a particular area (e.g., Consumer Insights) we bring in additional experts as required.
- Funding approvals by the Board take into account all feedback given by the above advisory groups, and also take into consideration Vision Mātauranga.

Management and Accountability

As per Tranche 1, the HVN Management team will include:

1.0 FTE Challenge Director – Joanne Todd

0.5 FTE Chief Scientist – Under recruitment

1.0 FTE Research Operations Manager – Robyn Nesbitt

0.5 FTE Senior Marketing and Communications Advisor – Gilbert Wong

We will be supported by a 0.5 FTE Administrator – Eleanor Surtida, who is funded by the Host Institution.

Annual performance assessments will be conducted according to University of Auckland processes with the input of the Board Chair.

HVN will be supported by the Research Operations Centre within the University of Auckland, who provide financial management and contract management services. Regular accounts of financial management will be provided to the Board, and audited as per standard University processes.

We will continue to use KPIs developed for HVN as an overall performance measure. These currently include the following areas, which will be reviewed with MBIE to ensure continued relevance for Tranche 2:

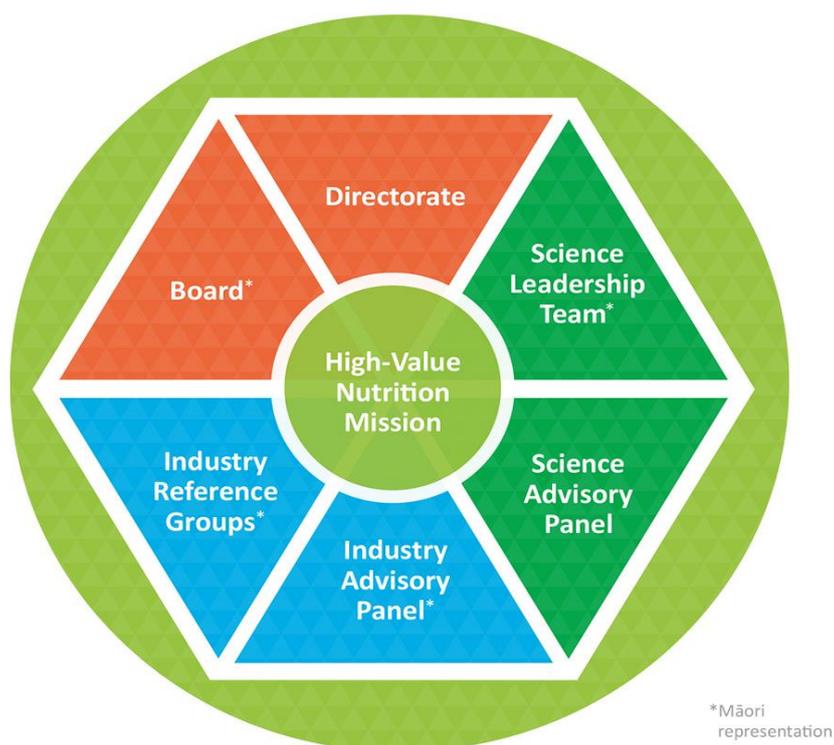
- Delivery of Challenge Objective
 - Investment in programmes evidenced with consumer need and demand, and business endorsement
 - Development and/or use of biomarkers to establish food-health relationships
 - Number of businesses using HVN capabilities to develop and/or support high-value nutrition products
 - Number of discrete F&B products involved in HVN research
 - Value of R&D investment by F&B businesses in HVN capabilities
 - Number of evidence dossiers submitted in support of health claims
 - Value of export revenues from F&B products supported by evidence based on HVN research

- Enhancement of NZ's reputation as a food producer of high quality and scientifically validated food health benefits
- Science Quality
- Best Research Team Collaboration
- Stakeholder Engagement
- Māori Involvement and Mātauranga
- Effective Governance and Management
- Public Participation

Overall structure

HVN will operate with a fully integrated structure of governance, management, science leadership, advisory panels and industry reference groups. They all interact together at various levels, aligned to the HVN mission:

High-Value Nutrition Governance, management and advisory structure



Hosted by the University of Auckland. Funded by the Ministry of Business, Innovation and Employment.



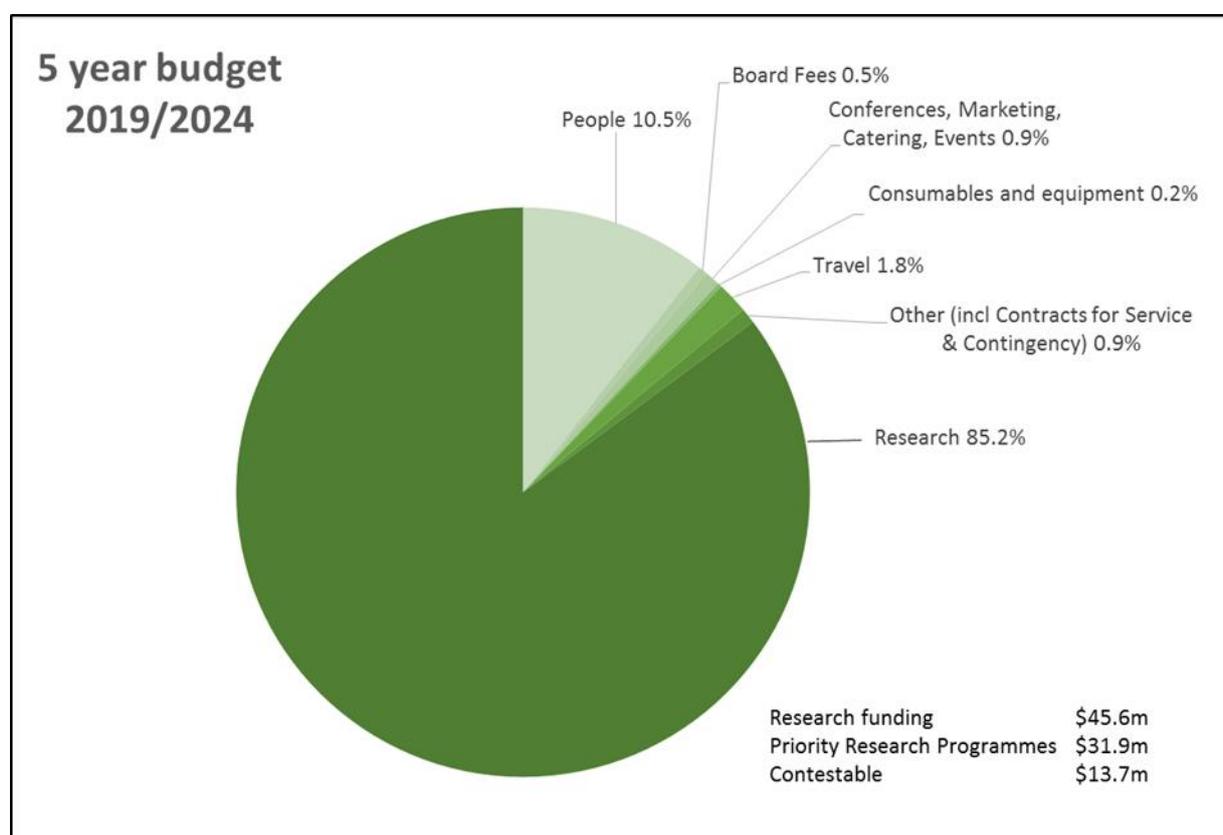
2.2.5 HVN 5-year indicative budget

The proposed budget for Tranche 2 is \$53.2m NZD. This will complete the full allocation of the originally proposed budget of up to \$83.8m over 10 years. It is proposed that 85% of the budget is allocated to research, with the remaining 15% for people and operational costs. The allocation for Tranche 1 was 80% research, 20% people and operational costs. With the larger amount allocated in Tranche 2, proportionately more can be spent on research.

The allocation of the research budget across priority/contestable (including special projects) research will be 70/30. This will enable significant investment in clinical research, as well as the on-going refreshment of Challenge teams and activities through contestable funded projects which complement and enrich the overall programme. While we are conducting clinical trials in NZ, it is intended that the majority of samples will be analysed in NZ, maintaining a significant investment in NZ capabilities.

Each health theme will be allocated a budget following a process of bringing together the best research teams, and when more detail is known on specific programme activities. Budget allocation will reflect the size and number of activities, and the extent of clinical studies undertaken. Budget will be reserved to enable the design of a clinical intervention study on the multi-factorial Chinese Urban Phenotype towards the end of Tranche 2.

People and operational budget estimates have been based on an analysis of actual and forecast costs from Tranche 1. The proposed breakdown is shown below:



3. Scenario Planning – Apportioning Additional Investment

HVN will achieve significant impact with the current proposed funding, however if more was to be available, we could further develop our programme integration and impact on Vision Mātauranga. The aspiration to understand and impact on the health of the ‘China Urban Phenotype’ is ambitious, and will require significant funding to conduct the proposed clinical study towards the end of Tranche 2. Funding is likely to limit the number of products/ scale of the study we are able to conduct, yet this work is unique globally and likely to attract much attention.

Traditionally clinical studies consist of three dimensions: genetics, environment and the condition under investigation, with research investigating variance in the first two dimensions. We would undertake the unique approach of varying the third dimension, comparing multiple conditions, while keeping the first two dimensions constant. Studying multiple conditions against the same genetic and environmental background will allow us to decipher a complex, multi-condition phenotype. This is to our knowledge a globally-unique approach to holistically understand and improve health through nutrition across multiple conditions. This is not only scientifically ground-breaking but also intuitively relevant to consumers, who want to manage their health across multiple conditions with validated nutrition and food products, but without compromising individual conditions.

Additional funding may give the ability to conduct multi-centre trials, to evaluate multiple product types/combinations among populations. This will enable greater delivery of evidence for businesses to market products with validated health benefits, in areas of high priority to consumers.

In addition, more funding could allow greater integration of the exploration of indigenous foods/ingredients that will be of interest/benefit to Māori owned businesses across all programmes. While there is a lot of knowledge about their potential holistic benefits, there is much work to be done to understand how these benefits relate to specific bioactives or bioactive blends, and whether these could be more fully promoted via a deeper understanding of how they influence health using advanced technologies such as metabolomics.

The Challenge would seek to “marry” indigenous knowledge with Western systems biology. In practice we would select natural products and extracts based on traditional Māori use, and scientifically investigate why and how they work in certain populations, but maybe not in others. This would guide us on a path to personalised traditional nutrition with validated health benefits for consumer groups that are large enough to be economically meaningful and defined enough for significant health effects. While this concept is still being pursued in the context of Traditional Chinese Medicine, the challenge there is the difficult standardisation of traditional Chinese natural product extracts and products. By contrast, Māori knowledge not only covers the traditional application but is already incorporated in the standardised manufacturing of NZ natural products and ingredient blends.

We are currently limited in the number of food products we will be able to use in clinical trials, and will most likely need to select those with a reasonable level of proof of efficacy from pre-existing scientific studies. If we were able to enhance knowledge of the scientific efficacy of potential ingredients of value to Māori owned businesses, that would allow greater participation/representation of these products/ingredients in HVN studies.

Finally, given sufficient funding, HVN would deliver a NZ-wide biomarker development and validation resource collating all the knowledge and local capability to deliver biomarkers for selected nutritional/health effects in specific health conditions. This would be of lasting value to the NZ nutrition and health science community and maintain the capability and capacity of HVN expertise in metabolomics, proteomics and microbiomics for the long term.

Appendix 1 Glossary and Abbreviations

Glossary

Bioinformatics –computational methods with the aim of extracting information from (pre-) clinical, biomolecular and genomic data to answer questions in biology, biotechnology and medicine.

Biomarker – a biological characteristic that is objectively measured and evaluated as an indicator of normal or pathological processes, or of a response to a therapeutic intervention.

Epigenome – chemical and structural changes to DNA, that do not affect the DNA sequence, and switch genes on and off. In contrast to the genome, the epigenome is dynamic: it changes with time and space (tissue) within the same organism.

Epigenomics is the comprehensive analysis of the state of gene expression not attributable to mutational changes in the underlying DNA sequence.

Immuno-metabolism – the interface of immune and metabolic processes in health and disease.

Metabolites – products of metabolic reactions catalysed by various enzymes that naturally occur within cells.

Metabolome – all metabolites (small molecules produced by cells during metabolism) present within an organism, cell or tissue.

Metabolomics is the comprehensive analysis of all these metabolites, typically in human body fluids, to understand the influence of genes, microbiome, diet, and lifestyle on the metabolic phenotype.

Metagenomics – the study of all genomes of micro-organisms, in our case most important in the human gut to provide information on the microbial diversity and ecology of a specific environment.

Microbiome – the microbial community that colonizes a given, typically human, organ such as the gut.

Microbiomics – is the comprehensive genomic and bioinformatic analysis of these microbiomes to gain insights into microbiome metabolism and it's effects on the host (human).

Molecular phenotyping- the comprehensive measurement across categories of molecules (i.e. genomics, transcriptomics, proteomics and metabolomics) to molecularly characterise a phenotype.

'Omics' – overarching term for the technologies that enable the comprehensive analysis of genes, transcripts, proteins and metabolites in a specific biological sample.

Phenotype – the observable characteristics of an organism that result from the interactions of its genotype (total genetic inheritance) with the environment.

Primary Growth Partnerships – a joint venture between government and industry, that invests in long-term innovation programmes to increase the market success of the primary industries.

Proteome – the complete set of proteins expressed by an organism, tissue or cell. Proteins are the “molecular robots” in any living organism that effectuate and catalyse all biochemical reactions. Unlike the genome, the proteome is dynamic: it changes with time and space (tissue) within the same organism.

Proteomics is the comprehensive analysis of these proteomes.

Strategic Science Investment Funding – an MBIE fund that incorporates a range of research programmes and infrastructure that helps deliver on the vision of the National Statement of Science Investment.

Systems Nutrition – the new nutrition science that understands humans and their diets and health as a result of the interplay between genetic inheritance, food and environment. Systems Nutrition is the nutritional analogue to Systems Biology. These Systems Sciences contrast with traditional ‘reductionist’ science that attempts to study individual parts of any biological system in isolation.

Abbreviations

AgMardt	Agricultural Marketing and Research and Development Trust
CAGR	Compound Annual Growth Rate
CAPEs	Centres of Asia Pacific Excellence
Co-PI	Co-Principal Investigator
CoRE	Centre of Research Excellence
CUP	Chinese Urban Phenotype
EU JPI	European Commission Joint Programming Initiative
F&B	Food and Beverage
FGD	Functional Gut Disorders
FSANZ	Food Standards Australia New Zealand
HRC	Health Research Council
HVN	High-Value Nutrition
IAP	Industry Advisory Panel
IBS	Irritable Bowel Syndrome
IRG	Industry Reference Group
IP	Intellectual Property
KPIs	Key Performance Indicators
MBIE	Ministry of Business Innovation and Employment
MPI	Ministry of Primary Industries
MRI	Magnetic Resonance Imaging
NCDRCRC	Non-Communicable Diseases China Research Collaboration Centre
NSC	National Science Challenge
PI	Principal Investigator
PGP	Primary Growth Partnerships
PRPs	Priority Research Programmes
R&D	Research and Development

SAP	Science Advisory Panel
SLT	Science Leadership Team
SMEs	Small and Medium Enterprises
SSIF	Strategic Science Investment Funding
T2DM	Type 2 Diabetes Mellitus



Nāku te rourou nāu te rourou, ka kī te kete
With my basket and your basket, the kit will be full

**HIGH-VALUE
NUTRITION**

Ko Ngā Kai
Whai Painga

National
SCIENCE
Challenges