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Food Systems, Indigenous Knowledge and Systems Thinking: A Case Study in Regional New Zealand

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Abstract

Background: The nutritional health of tamariki (children) in Aotearoa New Zealand (NZ) is poor. Nourishing Hawke's Bay (NHB) began as an initiative to address this problem in low advantage regions of Hawke's Bay (HB) and evolved into the evaluation of Ka Ora. Ka Ako the free, healthy school lunch programme, and the scoping of wider improvements in the regional food ecosystem.
Purpose: The aim of this paper is to describe how NHB co-designed and evaluated food interventions incorporating systems thinking and mātauranga Māori (traditional knowledge), as lenses through which to view the initiative.
Study Sample and Research Design: Cognitive mapping interviews (n = 11) with community health and education leaders identified six key co-design principles or Pou (metaphorical posts) for NHB.
Data Collection: Further systems methods, such as group model building and system dynamics modelling, and mātauranga Māori methods, such as wānanga (Māori learning forums), involved the community in food systems mapping and intervention co-design and prioritisation.
Results: Three Pou, 'food security,' 'mātauranga Māori' and 'children's hauora' (wellbeing), set the research agenda for NHB. the other three Pou, 'work with community,' 'cohesion and integration' and 'start with schools,' determined the subsequent research processes. Along with standard population evaluation methods (including quantitative and qualitative assessments of changes in student health and wellbeing), a participatory Value for Investment (VFI) analysis assessed return on investment.
Conclusions: Combining systems thinking and mātauranga Māori is a novel, participatory approach co-creating pathways to improved nutrition and food security for tamariki and holds promise for wider food system changes in regional NZ.

Keywords

mātauranga Māori, indigenous knowledge, systems thinking, food systems, schools, education, food security

Introduction

Globally, health, wellbeing, food security and economic prosperity are being severely impacted by the current food system.[1] As a result, there is now momentum building in the wider food sector, beyond food enterprise (the marketing of food), food security (the adequacy of food supply) and food rescue (the prevention of wastage), that includes concepts such as food justice (the equitable access and fair distribution of nutritious and culturally appropriate food), food citizenship (the rights, responsibilities, and agency of individuals and communities within the food system) and food sovereignty (the authority that individuals and communities have to manage and shape their own food and agricultural systems).[2]

In Aotearoa New Zealand (NZ) in 2023, one-fifth of all children and one third of Indigenous Māori children lived in food insecure households.[3] Unhealthy diets are also driving the rising prevalence of obesity and diabetes.[4] These nutrition-related conditions contribute to disproportionate burdens of ill health for Māori and people from lower income households.[3,5] Hawke's Bay (HB) is a huge food producing region of NZ,[6] but paradoxically, food insecurity and obesity are above the national average.[7] HB has not experienced the recent national decreases in obesity prevalence among pre-school children, and more than 33% of children are now classified as overweight or obese.[8] Māori, like other Indigenous populations, have close cultural connections to the land

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and a holistic approach to food and health,[9] and this can create an alternative narrative to food as an economic commodity. Strengthening such food systems to make communities more resilient and lifestyles more sustainable will promote food security and food justice.[10]

Nourishing Hawkes Bay (NHB): He wairua tō te kai (there is life, wellbeing and meaning to be found in food) was established in 2020 as a collaborative initiative between researchers and the HB community, particularly Māori and low advantage schools and communities where food insecurity is prevalent. Its funding came mainly from government sources – the National Sciences Challenge – A Better Start. NHB's vision was '*to improve health equity for children, young people and families by shaping future food systems across Hawke's Bay*' and its mission was to '*use systems thinking and mātauranga Māori to better understand and support food-related outcomes for tamariki (children), whānau (families), schools, communities and the environment*.' The NHB researchers were a diverse team catering to the expertise needed for carrying out such a multifocal project. Researchers were predominately on the ground in HB, supported by experts elsewhere in NZ. The team identified as both Māori and non-Māori, and the authors of this paper were senior researchers, inclusive of experts in food systems, Indigenous knowledge, systems thinking, and programme, economic and policy evaluations.

NHB used three major participatory research and knowledge approaches to engage with the priority community (Māori), co-design the interventions and research, and feedback the findings for sense-making. Figure 1 shows these approaches: mātauranga Māori (traditional knowledge), systems thinking and methods, and the programme, economic and policy evaluation tool. This led to a number of projects, many of them centred on Ka Ora, Ka Ako, (the NZ governments free, healthy school lunch programme) that was introduced in 2020 (as part of the Covid economic recovery programme) to a quarter of primary and secondary school students by targeting schools with the most disadvantaged students. Ka Ora, Ka Ako is the most substantial child nutrition initiative NZ has had and because HB is a region of low advantage, it provided lunches to 40% of students.[11]

The purpose of this paper is to describe the NHB approaches and progress as a case study of participatory research to improve children's nutrition. It aims to bring together different knowledge systems and methods as a novel approach to activating and evaluating food systems changes at a regional level.

Knowledge Systems and Methods

Systems thinking and mātauranga Māori are the lenses through which NHB have negotiated the application of community-based participatory research in the local HB context.[12] Their associated bodies of knowledge and practice are embedded in research activities; they are the way that the NHB team, half of whom are Māori, see the world. This is novel and, in some respects, unique in academic research.[12] Systems thinking refers to a way of dealing with complex systems including their elements, interconnections, functions or purpose. It comprises, theories of systems and also methods and tools for exploring those systems.[13] Systems approaches try to understand the behaviours of the whole system by mapping the variables in the system and the relationships between them.

The synergies between this and mātauranga Māori have been discussed at length by McKelvie-Sebileau et al[12] and supported by the work of Heke et al.[14] However, a key link between systems thinking and mātauranga Māori worth mentioning is systems thinking's emphasis on connections

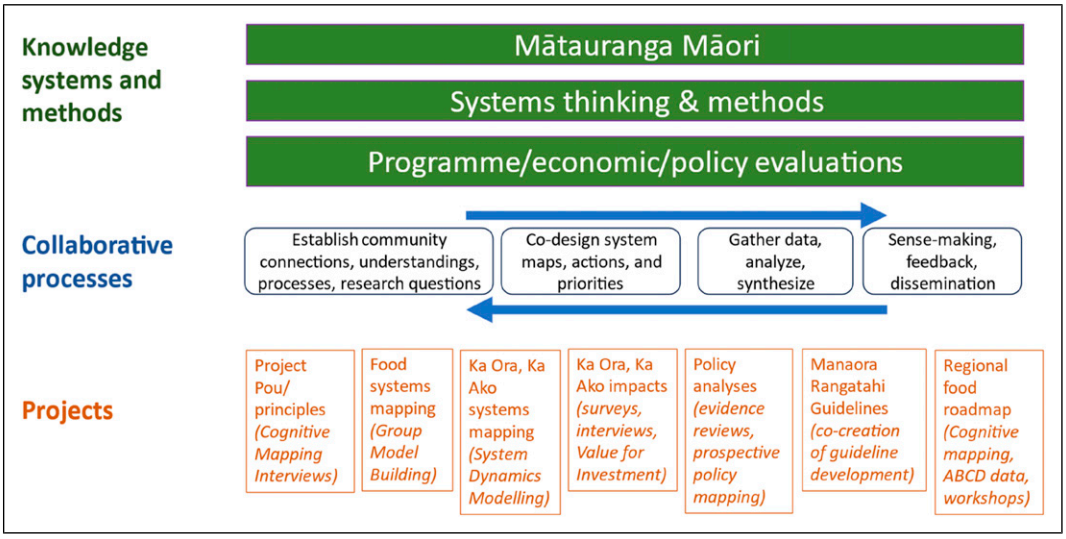

Figure 1. An overview of Nourishing Hawkes Bay's knowledge systems, processes and projects (ABCD is asset-based community development).

and the Māori concept of whakapapa (genealogy). In both knowledge systems there is a strong focus on the connections between things rather than the things themselves. It is the connections between things that generates what we see and experience and, importantly, if one wants to changes what is going on in the world one has to understand and change the connections.

Mātauranga Māori

Mātauranga Māori processes came to the fore as NHB researchers engaged with Māori as significant participants in this research. For example, the personal networks of the Māori researchers themselves were critical to the recruitment and retention of research participants and the workshop engagement methods were based largely upon tikanga Māori (customary ways of doing things). At a more intellectual level, mātauranga Māori incorporates the understanding of customary and cultural practices and encompasses both physical and non-physical elements supporting health and wellbeing for Māori[15] and more specifically, wellbeing with respect to food.[16] Indigenous peoples have a close connection to the land, a holistic approach to food and health that is intertwined with culture, identity, and spirituality.[17,18] Food is thereby intimately linked with celebrations, social gatherings and associated ceremonies and traditionally, Māori food systems are predicated upon the cultural touchstones of atua (departmental deities) and pūrākau (creation stories). More practical elements include gardening, foraging and hunting practices.[19] The promotion of traditional knowledge in these ways fosters social cohesion and community resilience. The contribution of mātauranga Māori to sustainable food systems will require Māori to be leaders in local food production and distribution, and the knowledge around traditional production, processing, and preservation will require careful documentation. The investment in Māori food infrastructure will improve access to land, water and resources for local Māori food producers and the education of the public should promote the importance of Māori food systems and the value of Māori kai (food).

Systems Thinking

Systems thinking has a number of sub-fields and the majority of work done by NHB is in the fields of community-based system dynamics (the participatory approach of involving the community and building their capability in the systems methods and tools used in the process)[20] and system dynamics modelling, which creates models based on cause-and-effect relationships, especially operating through positive (reinforcing) and negative (balancing) loops. The models can be qualitative or quantitative.

Common methods for developing qualitative models are semi-structured interviews, often using cognitive mapping to structure the interviews, and group model building (GMB). Cognitive mapping is a tool used to capture participants' mental models and they portray participants causal thinking of the issue at hand. The mapping process marks relationships between identified variables and whether these are positive or negative.[21] Individual cognitive maps (participants interviewed one-on-one) can be combined as a composite map to describe the interviewees' thinking as a whole. Cognitive maps can also be developed into causal loop diagrams, or causal loop diagrams can be generated directly from GMB. Causal loop diagrams aim to understand the mechanisms driving behaviours within a system by identifying the structure of causal relationships and feedback loops.[22]

GMB is a participatory co-design method whereby community members or stakeholders are engaged in the process of understanding system structures or complex system causes.[23] The group, led by a facilitator, exchanges perceptions of problems, solutions and barriers.[20] GMB explores the relationships, often in the form of positive and negative feedback loops, that determine system behaviours and the actions to influence the system based on an understanding of the system's dynamics and leverage points.[24]

Quantitative simulation models are used to test the themes and findings of the qualitative approaches. This in effect converts qualitative systems maps into a 'stock and flow' model by adding data to the variables (stocks) and directional arrows (flows) and running the model over time so that it can reproduce observed past trajectories and create scenarios for future trajectories. Once the model is running with confidence, multiple scenarios can be run to show the effects of different settings for the stocks and flows (sensitivity analyses) and for different interventions. These scenarios help decision-makers to understand the system's behaviours and to test out various intervention options in silico.

Much of the conversation about food and nutrition in the context of Ka Ora, Ka Ako has been about food composition, that is, does it meet the nutrition guidelines. While acknowledging the importance of nutritious food, systems thinking encourages people to think about the broader context of who grew the food, where was it grown, how was it grown, and how does the whole process of growing and distributing food affect the communities within which the food system operates. Systems thinking helps to focus attention on the broader food system, understanding how connections between local farmers, food processors, distributors, and consumers, affects important issues like improving access to affordable and fresh produce in underserved areas and reducing food waste by creating more efficient supply chains.

Evaluations

The third set of knowledge systems and methods includes programme, economic, and policy evaluations which answer questions on how well interventions are going in achieving their goals and how they could be improved. To complement the evaluations funded by the Ministry of Education[25] some

standard programme evaluations of Ka Ora, Ka Ako have been included in NHB such as serial cross-sectional surveys of Year 5 and Year 9 students' behaviours, anthropometry and quality of life[7] serial school food environment surveys[26] qualitative interviews and focus groups,[22,27] and a literature review of the impacts of free school lunches.[28] The cross-sectional surveys have to date been completed twice at three-yearly intervals (2020[7]/2023). Over time this will show changes in health and wellbeing for children in HB, as well as more specifically for children in schools participating in the Ka Ora, Ka Ako programme.

In addition, two other notable evaluations of Ka Ora, Ka Ako have been included. The first is a prospective policy pathways analysis of how the programme can add value to several national policy and strategic initiatives. The multiple impacts of Ka Ora, Ka Ako for the child, family, school, community and wider food systems[28] means that it can contribute to health, educational, sociocultural, environmental and economic outcomes and policy priorities. However, significant enhancement of the programme would be needed to fulfil these potentials.[29]

The second notable evaluation is a return-on-investment analysis using the Value for Investment (VFI) methods developed by Julian King.[30] VFI is a participatory method whereby stakeholders (i.e., local HB schools and community and the Ministry of Education) determine what 'values' they expect the programme to deliver. These values are then placed within the Economic 5-E framework – effectiveness, efficiency, economy, equity, and cost-effectiveness. There were 21 stakeholder-determined values which were entered into the 5-E framework. These needed to be framed in a way that evidence could be applied to them so that the original stakeholders could make a value judgement about the degree to which each value was being met by the programme (rated as excellent, good, adequate, or poor)[31] Unlike standard cost-benefit analyses (where all benefits have to be monetised) or cost-effectiveness analyses (where all benefits have to be condensed into a single metric such as disability-adjusted life-years saved), VFI allows a wide variety of evidence to be put to stakeholders to allow them to make judgements.

The participatory nature of the VFI process made it particularly suitable for NHB given the Pou (see below) of working with the community. VFI also closely interlinked with other parts of NHB such as the system dynamic model, the review of impacts of free school lunches,[28] the policy pathways analysis and the wide range of impact data collected on Ka Ora, Ka Ako.

Project Pou/Principles

At the outset, NHB used cognitive mapping with key community stakeholders in health and education leadership to explore the 'underlying drivers of rising childhood obesity and engage the community to improve the food environment'. From these interviews came the NHB Pou (Figure 2), the metaphorical 'principles' – the values and the standards which guided the initiative.[32] Three of the Pou, address '*Food security*,' incorporate '*mātauranga Māori*,' and keep a wide focus on '*children's hauora*' (wellbeing). These Pou set the research agenda and the direction in which the projects should head. The original focus of reducing childhood obesity was changed as a result of the community interviews to improving children's hauora so that the framing was broad, positive and non-stigmatising. The other three Pou, '*work with community*,' enhance '*cohesion and integration*' across community actions, and '*start with schools*' guided the processes of the research. These processes interlink and overlap but for ease of reader understanding are discussed under individual headings. The Pou ensured that the needs of the community and the utilisation of community-based participatory methods were at the forefront of the research. The Pou offered the opportunity for the research team to reflect upon their direction and provide reassurance to the community that researchers are continuing to meet their needs and the following sections describe the research programme initiatives that emerged out of the Pou.

Working With the Community

The cognitive mapping interviews that gave rise to the Pou were the starting point for a series of GMB workshops exploring poor nutrition in the HB community.[33] These workshops were the first opportunity that NHB had to engage in a participatory process with community members as a group. This was also the beginning of the practical application of the synergies between systems thinking and mātauranga Māori (Figure 3). During the GMB workshops with community members and rangatahi (youth), one facilitator acted as pā whakawairua (spiritual leader), holding the essence of the workshops with tikanga, whanaungatanga (relationships), manaakitanga (hospitality) and pūrākau incorporated as analogies to explore the GMB tasks asked of participants. Pūrākau and their atua were used to explain complex system terminology from the perspective of a Māori worldview. Causal loop diagrams explored the relationships between the variables developed with the community and a matrix of interventions plotted the feasibility and impact.

Working With Schools

Ka Ora, Ka Ako was introduced at the beginning of the NHB initiative and provided a prime opportunity for a research focus to meet the Pou of 'start with schools. Qualitative studies[11,34] (interviews and focus groups with students, principals and parents) explored food security and the impact and lived experiences of Ka Ora, Ka Ako at the individual, whānau and school levels. Several positives of the programme and areas for improvement were identified. For example, having an external provider just drop off the food at

Figure 2. The six Pou for the implementation of the project Nourishing Hawke's Bay: He wairua to te kai (there is life, wellbeing and meaning to be found in food).[32]

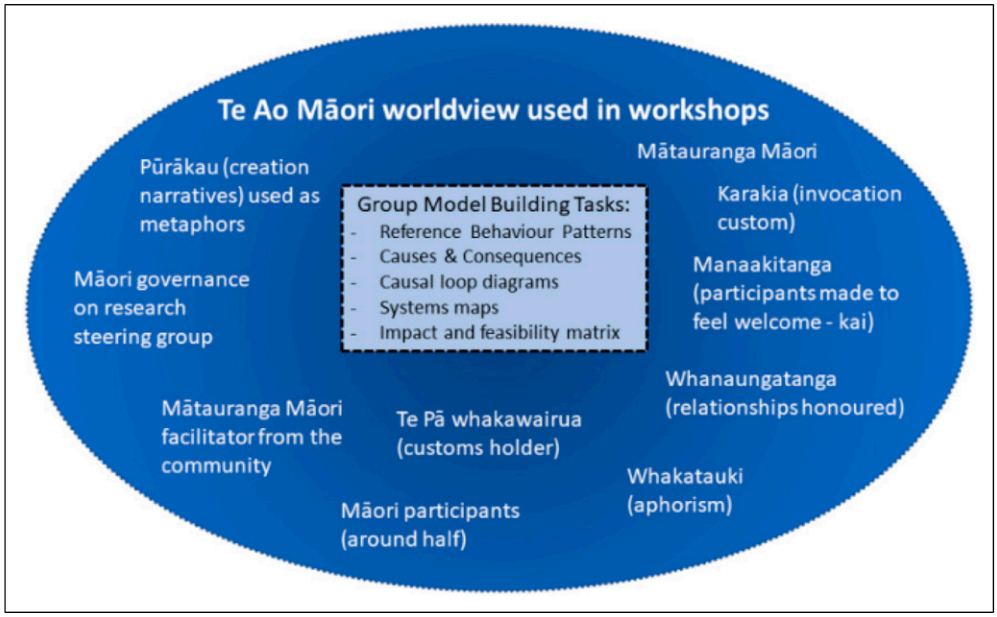

Figure 3. The standard methods of group model building (in the central box) embedded within elements from mātauranga Maori (Māori knowledge) and Te Ao Māori (Māori worldview).[33]

the school did not fit within schools Te Ao Māori (Māori worldview) and mātauranga Māori inspired perspectives of kai and eating. It changed the meaning of food, which previously for one school was bound in the wider meanings and values of kai. It was also found that Ka Ora, Ka Ako was not aligned to mātauranga Māori.[34] However importantly there is significant potential for further integration.

Systems thinking is a novel approach to analysing school lunch programmes worldwide and NHB's earliest work with Ka Ora, Ka Ako, used systems maps to identify areas for

improvement and issues within the programme in HB. Lunch providers (both on-site and external) were interviewed to understand an operational perspective of the programme.[22] Individual cognitive maps were created with this data which were then merged into a composite map. Feedback was sought from participants to ensure their mental models had been captured accurately. The composite map was then used to create causal loop diagrams showing a visual representation of the interactions between key variables that had been identified as those that would lead to the success of the programme in HB. The causal loop diagrams were also able to pinpoint areas where intervention may occur.[22] This work was used as a starting point for identifying the data needed for a quantitative simulation model.

Simulation Modelling. Further engagement with key stakeholders was needed to build a strong business case for sustainable funding of an enhanced model of Ka Ora, Ka Ako. Through a participatory approach consisting of interviews, GMB workshops and input from schools and suppliers, a system dynamics simulation model of Ka Ora, Ka Ako was built. The model simulates the likely impacts of Ka Ora, Ka Ako and tests alternative options to contribute to the development of the programme and to influence local, sustainable food systems. The model supported a business case for ongoing development of Ka Ora, Ka Ako and demonstrated how coherent procurement strategies of such a large programme can become a 'platform for food system change' by stimulating more local and sustainable food supply chains.

Working With Rangatahi. Through schools, NHB engaged with rangatahi (15–16-year-olds) to develop a set of healthy eating and wellbeing guidelines; the Manaora Rangatahi Guidelines.[35] The NZ government publishes food and nutrition guidelines for sub-populations ranging from infancy to elderly, purposively developed to fit the sociocultural context of NZ. However, the adolescent-specific guidelines,[36,37] were dated, did not resonate with rangatahi and were virtually unused in education.

The rangatahi involved in this project were engaged in a series of three wānanga at a local marae (Māori community facilities) which consisted of learning about current national and international guidelines and hearing from several experts in nutrition, physical activity and wellbeing. From this input, the rangatahi developed 20 healthy eating and wellbeing guidelines that were bound in Te Ao Māori and rangatahi voice to aid in increasing healthier behaviours among others in a similar age range.[35] The third wānanga saw the rangatahi engage with influencers and a film crew to film videos associated with each message to disseminate in a social media campaign, designed to capture attention and engagement. This process was led by mātauranga Māori. NHB has provided a platform for innovation and co-creation of resources to improve nutrition and hauora.

Cohesion and Integration

Networks are a vital component within systems thinking and mātauranga Māori whereby knowledge about and engagement with an issue can disseminate through a community.[12] NHB established a knowledge exchange action network (KEAN) for school cooks in the early days of the Ka Ora, Ka Ako programme when the learning curve was at its steepest to enhance the flow of knowledge and engagement. KEAN meetings were held once each school term and were highly valued by KEAN members. This illustrates the value of providing platforms to enhance the opportunities for community members to get together to learn from each other and problem-solve.

Through the cognitive mapping at the outset of NHB and subsequent community hui (meetings), it was identified that much more 'cohesion and integration' was needed across food-related initiatives in HB. The goals across these initiatives were similar in that they were working towards improving food systems to become healthier, more equitable, and more environmentally sustainable whilst maintaining economic sustainability, but they were generally working in isolation from one another and there was little collaboration towards this broader, common goal.

This led NHB to take on a regional 'Food Road Map' project to better serve the Pou of cohesion and integration. This involved interviews with food system actors in the region, using cognitive mapping techniques and the principles of Asset Based Community Development (ABCD).[38,39] The ABCD approach aligns closely with systems thinking in that it starts from the perspective that communities already have many of the resources they need to move forward, and that the task of action researchers is to shine a light on those resources, help the community connect them together and highlight what other support is needed for the community to flourish. It is also a strengths-based approach, in contrast to historical approaches that have often been developed with top-down thinking leading to deficit framing. Relationships and community connections are central to the ABCD framing thus closely aligning it to mātauranga Māori and systems thinking.[14]

Discussion

This case study has combined three bodies of knowledge and methods to explore ways in which to engage with community to work together to combat food insecurity, improve child health, and potentially transform regional food systems. This work was guided by a set of Pou that was developed at the outset of the project with the local community. In particular, the Pou changed the framing from reducing childhood obesity to improving children's hauora, the community insisted on the centrality of using mātauranga Māori, and determined how NHB would need to work to add value to the existing efforts of the community.

Prior to NHB's innovative approach, little was known about the health and wellbeing of tamariki in the HB area. Through the combination of mātauranga Māori, systems science methods, and multiple evaluation approaches, NHB generated high quality research that has been co-designed and carried out with the community to develop a plan to tackle food insecurity in the local region. This initiative has not only provided community-led ways of engagement with the local community, but there are now multiple baselines of work that can be used to understand changes over time in this regional community.

The systems thinking methods were critical for structuring food systems mapping, guiding community interventions based on system leverage points, and creating a quantitative system dynamics model of Ka Ora, Ka Ako for scenario testing. The use of the systems approach has allowed for a different understanding from the traditional take on problems or issues in society which are often top down whereby researchers often act without consultation with those on the ground. The systems thinking tools have encouraged a participatory framework making community consultation and the intention to codesign the first points of action for research activities.

Mātauranga Māori was critical for achieving community engagement, guiding the participatory processes, and anchoring interventions and analyses in Te Ao Māori. This inclusion has generated trust in, and respect for, the research team from community members and the faith that their interests, issues and solutions are at the forefront. Engagement in Māori practices such as tikanga, processes designed to keep people safe and whakawhanaungatanga (the building of relationships) designed to make sure people know and are able to relate to one another occurred) throughout the research. Thereby, the relationship with (and within) the community was further enhanced, and has brought about a wider sense of collaboration. These knowledge bases and processes are highly complementary and provide a promising set of research tools to catalyse and guide regional food systems transformation.

Ka Ora, Ka Ako encompasses all aspects of food production and disposal, making it an ideal platform to address issues related to waste, hunger, local food production, and the social and cultural importance of food. School food programmes worldwide have successfully provided sustainable benefits for hunger, public health, and local food production in both urban and rural areas, regardless of a country's economic status.[28] The most sustainable, long-term school food programmes create work, training, and other economic and mana (prestige)-enhancing opportunities in their communities. There is ample international evidence about the value of school lunch programmes in other Western countries.[40–44] This includes lifelong educational and health benefits to recipient children, economic gains for their households/families, better school learning environments, job creation in the community, and increased food system resilience. NHB have previously presented the global evidence base on school lunches to fill the gaps in local evidence for the Ka Ora, Ka Ako programme.[28] It is either too soon to measure these locally, or these have not yet been considered as relevant outcomes as they fall outside the Government's present evaluative framework. Nevertheless, through multiple evaluations, this case study has shown there are clear impacts of Ka Ora, Ka Ako in this regional community.

In addition to these findings, a well-designed and well-implemented Ka Ora, Ka Ako programme can enhance policy outcomes across a range of sectors including, education, health and the environment.[27,29,31] For example, there are opportunities for the existing or expanded lunch programme to link with the nutrition and health curriculum, to use its purchasing power to reduce carbon emissions from food through menu design and preventing food waste ending up in landfill, and to contribute to improving health equity through its effects on nutrition-sensitive such as dental caries, obesity and mental health problems.

Bringing together the rangatahi developed eating and wellbeing guidelines alongside the Ka Ora, Ka Ako programme would also potentially enhance the impact of each of them in terms of food literacy, dietary patterns and health and education outcomes. There is also potential for the programme to link more closely to local food production thus reducing food transport and improving the resilience of the local food ecosystem to events (such as cyclone Gabrielle which badly hit the region in February 2023).

Although this project has been a success in terms of generating new knowledge for furthering a sustainable food system for greater food security for the local region, it has not been without challenges. Networks and collaboration are a vital component of work in this area. However, despite common goals, coalition building within communities can be a major challenge in collaborating for the common good.[45,46] Commercial organisations must make a profit to be viable and not-for-profits, while not needing to make large profit amounts, may be vying for the coverage of their own wages, and this competition results in threats to employment and sometimes prestige. Further work needs to explore this in more depth. Although the community is heavily involved and invested in this work, participant burnout is a risk when working in a small community which often relies on the same busy individuals and groups doing the everyday work to also participate long term in the research. Finally, a foreseeable challenge within Indigenous food systems is that knowledge and expertise have been lost as a result of colonisation and urbanisation meaning, that within some communities there are few people who still possess traditional Indigenous food practices.

The NHB initiative provides a blueprint for co-creating regional food systems transformation. This should be measured in practice to ensure viability, effectiveness, pro-equity, and value for investment. This will demonstrate what food resilience looks like at a regional level, creating feasible

alternatives to current commercial food systems and finding other economically viable options for connecting local food production to local consumption. The challenge however, is in the long game of improving health (particularly long-term conditions associated with food) and promoting social and economic wellbeing by increasing food security and engagement in food-related activity and enterprises. Continuation of this work should remain focused around community-centred food systems that aim to see improvements in food security, education, health and wellbeing among tamariki.

Conclusions

Through combining the lenses of systems thinking and mātauranga Māori as a way of engaging with the local community through a participatory approach, NHB has provided novel understandings into co-created pathways to food security for tamariki in regional NZ. While maintaining commitment to the community developed Pou, this initiative is in the early stages of branching out to the wider community level and the benefit of a local sustainable food system for the whole whānau through Ka Ora, Ka Ako being showcased as an exemplary of such a system in a regional area. Utilising community assets and increasing collaboration are key to implementing these findings in a practical sense, and should be further explored.

Appendix

Glossary

Appendix A. Te Reo Māori terms in the manuscript. Definitions adapted from Te Aka Online Māori Dictionary.[47]

atua	Departmental deities
hapū	Sub-tribe
hauora	Wellbeing
hui	Meeting
He wairua tō te kai	There is life, wellbeing and meaning to be found in food
kai	Food
Ka Ora, Ka Ako	The NZ governments free, healthy school lunch programme
mana	Prestige
manaakitanga	Hospitality
Māori	Indigenous population of NZ
mātauranga Māori	Traditional knowledge
māra kai	Traditional food garden
pā whakawairua	Spiritual leader
pou	Metaphorical posts
pūrākau	Creation stories
rangatahi	Adolescent
tamariki	Children
Te Ao Māori	Māori worldview
tikanga	Customary ways of doing things
wairua	The spiritual aspect
wānanga	Māori learning forums
whakapapa	Genealogy
whānau	Family
whanaungatanga	Relationships
whakawhanaungatanga	The building relationships

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Ethical Statement

Ethical Approval

Ethics approval was obtained from the Eastern Institute of Technology.

Informed Consent

Written informed consent was obtained from all participants in this study.

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David Rees is a founding partner of Synergia Ltd, a research and consultancy organisation based in Auckland and Wellington. Since the early 1980s, has undertaken a lifelong study of the system sciences, taking courses and programmes with leading thinkers and academic institutions in the United States. His work and research focus on bringing his combined interests in qualitative and quantitative systems methods to assist in areas such as policy, strategy, population health and service design in health, education and social care. David is an Honorary Lecturer at Auckland University's School of Population Health and also presents on the application of System Thinking and System Dynamics to issues of health, education and social care at several other universities and government institutions. David has a PhD from Victoria University, Wellington, which focused on programmes to improve care for people with chronic conditions within the primary health care sector in New Zealand.

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