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New Zealand's Food System is Unsustainable: A Survey of the Divergent Attitudes of Agriculture, Environment and Health Sector Professionals Towards Eating Guidelines

A thesis presented in partial fulfilment of the requirements for the degree of
Masters of Science
In
Nutrition and Dietetics

Massey University, Albany
New Zealand

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2019

Abstract

Background: The United Nation's (UN) Sustainable Development Goals (SDG) address the adverse health and environmental changes associated with changes in the food and nutrition system. In one of its many sustainable development initiatives, the Food and Agriculture Organisation of the UN (FAO) has called for sustainable diets, which align with SDG 2, Zero Hunger, and SDG 12, Sustainable Consumption and Production. The inclusion of sustainability characteristics in New Zealand's (NZ) eating and activity guidelines (EAGs) would contribute to directly addressing the SDGs and lead to achieving sustainable diets. This study aimed to evaluate the agreement among sectoral professionals of including sustainability characteristics within the guidelines.

Methods: Professionals within the agriculture, environment and health sectors were invited to complete an online survey to establish agreement with sustainability characteristics. Opinion and attitude questions were completed using a 5-item Likert scale. One-way ANOVA analyses were conducted to compare the level of agreement with the inclusion of sustainability statements of the three professional sector groups. A one-way ANCOVA analysis was undertaken to detect a difference in means of the sectoral levels of agreement whilst controlling for covariates. Post-hoc tests were used to determine where the significant differences in opinion lay between the sector groups.

Results: Overall, 298 (65% female) respondents completed the survey from the agriculture (37%), environment (22%) and health (41%) sectors. Two-thirds (66%) of respondents were over 35 years and 90% had a tertiary education. Two-thirds (63%) of respondents disagreed with the statement that NZ's current food system is sustainable; sector respondents from health (77%) and environment (78%) had greater disagreement than agriculture (35%) ($P = 0.00$). Overall, 77% of respondents agreed that sustainability characteristics should be included in guidelines; with greater agreement from health (90%) and environment (84%) versus agriculture (58%) ($P = 0.00$). Five sustainability characteristics received unanimously high levels of agreement ($> 90\%$) for inclusion: dietary diversity (97%), sustainable seafood (90.8%), to limit processed foods (90.7%), reduced food waste (95.3%) and sustainable lifestyle behaviours (97.2%). Agreement for eight sustainability characteristics was higher for health and environment versus agricultural sector ($P < 0.05$). There was relatively lower level of agreement from all three sectors, particularly environmental (68.7%), to consume recommended serves of dairy products. Only 38.5% of all respondents agreed with the inclusion of "organic food produce". Respondents who agreed with the inclusion of sustainability characteristics were more likely to be familiar with the EAGs and to agree NZs current food system is unsustainable.

Conclusion: Professionals from the agriculture, environment and health sectors of New Zealand largely support the inclusion of sustainability characteristics within NZ's EAGs. However, there are areas of divergence that need to be addressed for their successful development and implementation.

Keywords: sustainability, attitudes, food-based dietary guidelines, agriculture, environment, health, professionals, sectoral

Acknowledgements

I would like to express my gratitude to my supervisors, Professor Barbara Burlingame and Associate Professor Carol Wham, for the valuable advice, time and opportunities they have provided me with throughout the study.

I would like to thank Louise McIntyre and all those at the Ministry of Health for your support and enthusiasm towards research in this area. I would also like to thank all those who participated in this study. Without your input and feedback, this thesis would not have been possible.

To my fellow Massey University Dietetics class of 2018, you are all brilliant and I am extremely grateful to call you, not only my peers, but my friends.

Lastly, my family. Mum, Dad, Jess and Henry, I'd like to thank you, most sincerely, for all the help you've given me since I began this crazy journey so many years ago. I especially appreciate all the time you've taken to help me find something I really believe in doing, and for being my rocks through all, and any, of the hurdles that were thrown my way.

I am truly passionate about this topic and hope this study contributes to a healthier and more sustainable food future for all.

Contents

Abstract	2
Acknowledgements	3
Tables	6
Abbreviations	6
Chapter 1: INTRODUCTION	7
Aims and Objectives	12
Structure of Thesis	12
Contributions of Researchers	13
Chapter 2: LITERATURE REVIEW	14
Sustainable Diets	14
Food System and Human Health	14
Food System and Environmental Health	14
Growing Awareness	14
Food-based Dietary Guidelines (FBDGs)	15
New Zealand	16
NZ: Dietary Trends	17
NZ: Human Health	17
NZ: Environmental Health	17
Summary of the NZ Dietary Situation	18
New Zealand’s Obligations	18
Current FBDGs in New Zealand	19
Development of Sustainability Characteristics in NZ FBDGs	19
Tailoring Guidelines to NZ	20
Implementation: Sustainability Characteristics in NZ’s FBDGs	20
Challenges	20
Successes	21
Learnings	22
Multi-sectoral Approach in New Zealand	23
Chapter 3: MANUSCRIPT	23
Abstract	24
Introduction	24
Methods	26
Purpose	26

Participants	27
Survey Design: Attitude and Opinion	27
Pre-testing the Questionnaire	27
Sample Size	27
Procedure	27
Statistical Analysis	28
Ethics	28
Results	29
Discussion	36
Strengths and limitations	40
Conclusion	40
Contribution to research	40
Chapter 4: CONCLUSION	42
Contribution to research	42
Strengths	43
Limitations	43
Final Recommendations	43
Recommendations for EAG Development and Implementation	43
Recommendations for Future Research	44
References	46
Appendices	55
Appendix A: Supplementary Methods	55
Appendix B: Participant Information Sheet and Participant Consent Form	59
Appendix C: Questionnaire	61
Appendix D: Chapter 16: Sustainable Diets	64
Appendix E: Ethics Report – Low Risk Letter	70

Tables

TABLE 1. DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS BY SECTOR.	29
TABLE 2. RESPONDENT AGREEMENT WITH SUSTAINABILITY STATEMENTS BY SECTOR.....	30
TABLE 3. RESPONDENT AGREEMENT WITH SUSTAINABILITY STATEMENTS BY SECTOR (MEANS AND SD).....	31
TABLE 4. RESPONDENT AGREEMENT WITH SUSTAINABILITY STATEMENTS WITH STATISTICALLY SIGNIFICANT DIFFERENCE ($P < 0.05$) BY SECTOR WHEN GENDER, AGE AND EDUCATION ARE CONTROLLED FOR.....	33
TABLE 5. CORRELATION BETWEEN INDIVIDUAL SUSTAINABILITY CHARACTERISTICS WHICH OBTAINED A STATISTICALLY SIGNIFICANT DIFFERENCE AND RESPONDENTS' AGREEMENT WITH SUSTAINABILITY STATEMENTS ($R < 0.05^*$, $R < 0.01^{**}$).	35

Abbreviations

ANCOVA - Analysis of covariance

ANOVA - Analysis of variance

EAG - Eating and Activity Guideline

FAO - Food and Agriculture Organization

FBDG – Food-based dietary guideline

GDP – Gross domestic product

GHG – Greenhouse gas

IPCC - Intergovernmental Panel on Climate Change

LRF Dairy Sweden - The Federation of Swedish Farmers

NZ – New Zealand

OECD – Organisation for Economic Co-operation and Development

SDG - Sustainable Development Goals

UN – United Nations

US – United States

WHO – World Health Organization

Chapter 1: INTRODUCTION

The global food system faces an ambitious challenge in meeting nutritional demands and mitigating disease whilst reducing greenhouse gas emissions (Steffen et al., 2015b; Rockström et al., 2016; Springmann et al., 2016).

Non-communicable diseases, including diabetes, coronary heart disease and certain types of cancer, are now prevalent in both high- and middle-income countries (Popkin, 2003; Speedy, 2003; Schmidhuber and Shetty, 2005; Popkin et al., 2012; Hallegatte et al., 2015; Scott, 2017). Worldwide, more people are now simultaneously malnourished and overweight or obese than underweight (Popkin, 2006). These statistics are directly linked to current and emerging dietary trends and contribute to the leading risk factors of the global burden of disease (McCarthy et al., 2001; Searchinger et al., 2014; Gakidou et al., 2017; UNSCN, 2017).

Further, all stages of food production, including primary production, manufacturing, storage, food preparation and consumption, impact on the environment (Rockström et al., 2016). Modern processes, associated with current and emerging dietary trends, have led to unparalleled and potentially irreversible environmental impacts (Steffen et al., 2015a; Steffen et al., 2015b; Whitmee et al., 2015). These include deforestation, greenhouse gas emission, damaged ecosystems, depleted fish stocks, soil degradation, water use and loss of biodiversity (Ramankutty and Foley, 1999; Steinfeld et al., 2006; De Fraiture et al., 2010; Tilman and Clark, 2014; Springmann et al., 2016; Clark and Tilman, 2017). Furthermore, and vice versa, climate change will affect the global food system, particularly the availability of primary produce including fruits and vegetables (Springmann et al., 2016).

In response to these challenges, the United Nations General Assembly declared the period 2016 to 2025 as the Decade of Action on Nutrition (FAO, 2016). As highlighted by the implementation of the UN's Sustainable Development Goals 2 ("end hunger, achieve food security and improved nutrition, and promote sustainable agriculture") and 12 ("responsible production and consumption"), the lack of sustainable food systems is at the centre of each of these paradoxical issues. Therefore, shifting towards sustainable diets has been identified as a common thread for tackling risks to both human and planetary health (Tilman and Clark, 2014).

It is not a new idea that there is a need for sustainable food production and consumption (FAO, 1998). An increasingly robust body of evidence suggests that dietary patterns, as seen in the Mediterranean diet, can be consistent with both good health and low environmental impact (Burlingame and Dernini, 2011; Tilman and Clark, 2014; Fresán et al., 2018).

Donini, Dernini, Lairon, Serra-Majem, Amiot (2016) defines a suite of the most appropriate nutrition and health indicators for assessing the sustainability of diets based on the traditional Mediterranean diet. These are as follows; biochemical characteristics of food including vegetable/animal protein consumption ratios, dietary energy adequacy, dietary energy density score and nutrient density of diet; food quality including fruit and vegetable consumption, dietary diversity; environmental factors including food biodiversity composition and consumption, rate of local/regional foods, seasonality and eco-friendly food production and/or consumption; and lifestyle factors including physical activity/inactivity prevalence, and adherence to the Mediterranean dietary pattern. Clinical aspects including diet-related morbidity/mortality statistics and nutritional anthropometry are also included (Donini et al., 2016).

A second reference for a sustainable diet has been provided by the EAT-Lancet Commission. They present a reference of global planetary health diet that is healthy for both people and planet. This provides a basis for estimating the health and environmental effects of adopting an alternative diet to standard current diets (Willet et al., 2019). The final report recommends that a planetary health diet consists of vegetables, fruits, whole grains, legumes, nuts, and unsaturated oils. Further it includes; a low to moderate amount of seafood and poultry, no, or a low quantity of, red meat, processed meat, added sugar, refined grains, and starchy vegetables; protein that should be sourced from plants as much as possible; fish or alternatives sources of omega-3 fatty acids should be included several times per week (196g/week). In addition, it recommends a 'modest' consumption of poultry (203g/week)

and eggs whilst reducing red meats to no more than 98grams per week with little to no processed meat. Most of the recommended diet consists of at least five servings of fruits (100-300g) and even more vegetables (200-600g) per day. Nuts (0-75g) and legumes (0-100) should be consumed each day and carbohydrates (232g/day) should be sourced from whole grains with low intake of refined grains and less than 5% energy from sugar. Dairy consumption is optional, however if consumed, moderate levels of around 250grams/day are recommended (Willett, et al., 2019).

Thirdly, twelve overarching sustainability characteristics of food groups, for potential inclusion in food-based dietary guidelines (FBDGs), have been identified based on their inclusion in international FBDGs. Dietary guidelines that integrate health and environmental sustainability considerations could be one tool for nutrition education and include the following recommendations; increase dietary biodiversity, consume a plant-based diets, moderate/limit red meat consumption, limit processed meat consumption, moderate dairy consumption, encouraging sustainable seafood consumption, limit processed and ultra-processed foods, promote water conservation in cooking, promotion of buying local and seasonal foods, encouraging food and packaging waste reduction, sustainable behaviours including exercise and cooking at home and, ethical animal welfare promotion. These sustainability characteristics contribute to both human and planetary health, as described in Figure 1 (Jones et al., 2019). Their presence, and absence, in international FBDGs are described in Figure 2(Jones et al., 2019).

Figure 1. Sustainable diet characteristics and rationale (Jones et al., 2019).

Characteristic	Rationale
Promotes diet diversity of whole foods	Diets that include a diversity of whole foods are linked to improved health outcomes by ensuring dietary adequacy, increased food security, a reduced intake of toxicant and protection against chronic diseases (Kant et al., 1993; La Vecchia et al., 1997; Michels and Wolk, 2002; Fozole et al., 2004; Jansen et al., 2004; Steyn et al., 2006; Armond et al., 2010; Vandevijvere et al., 2010). Agricultural biodiversity can help achieve nutrition security by supplying a wide range of nutrients, including phytonutrients, vitamins, and minerals (Toledo and Burlingame, 2006)
Promotes plant-based diets	Eating a predominantly whole food, plant-based diet is consistent with improved health outcomes and a reduced risk for many chronic diseases, certain cancers, obesity, and diabetes mellitus type 2. Additionally, plant-based diets require significantly fewer agricultural inputs such as energy, petroleum, fertilizers, pesticides, herbicides and water) and emit far fewer greenhouse gas emissions than meat-heavy diets (Timan and Clark, 2014; Malina et al., 2016)
Reduce/limit red meat consumption	Consuming high quantities of red meat is linked to numerous adverse health effects (Pan et al., 2012; Zelibor-Sagi et al., 2018). Meat from ruminant animals such as cattle and lamb is documented as being the largest food-based emitters of greenhouse gas emissions (Scarborough et al., 2014)
Reduce/limit processed meat	Processed meat is linked to certain types of cancer, cardiovascular disease, and diabetes mellitus type 2 when consumed in excess quantities (Chan et al., 2011; Boada et al., 2016)
Eat dairy products and alternatives in moderation	Dairy products can be a part of a healthy diet when consumed in moderation, however dairy is a significant source of greenhouse gas emissions (FAO, 2010). Some guidelines encourage the reduction of dairy, particularly if sweetened with excess amounts of sugar
Encourage sustainable seafood consumption	Seafood contains many essential nutrients including protein, calcium and omega 3 fatty acids. However, the demand for seafood has led to many species of fish becoming threatened due to overfishing. Choosing sustainable seafood options can reduce the ecological impact of overfishing (Jackson et al., 2001). Certain fish varieties are high in the neurotoxin methylmercury and should be consumed in moderation (Sheehan et al., 2014)
Limit ultra-processed foods high in fat and sugar	Ultra-processed foods have been stripped of the majority of their nutrients, and are often high in fat, sugar, and sodium. These foods are a significant source of calories for many around the world, yet do little to contribute to nutrition security (da Costa Louzada et al., 2015; Monteiro et al., 2010)
Water conservation and promotion	Many areas around the world are experiencing water security issues. Some dietary guidelines discuss the benefits of minimizing water in cooking and food production. Where water is safe to drink from the tap, many guidelines encourage tap water over bottled water, encouraging the reduction of plastic bottles
Promotes buying local foods	While the definition of 'local' varies considerably, local foods are shown to improve farmer-consumer relationships, increase revenue for small farmers, and encourage consumption of a wider diversity of foods (Brown and Miller, 2008)
Standards for the ethical treatment of animals	Animal welfare practices and standards vary widely from country to country. Dietary guidelines are beginning to promote the ethical treatment of animals as a part of a sustainable food system
Promotes reduction of food waste	Food waste occurs primarily in the developed world, with the majority occurring in the retail and consumer sectors. Reducing food waste can significantly reduce greenhouse gases while improving food security (Gustavsson et al., 2011)

Figure 2. Presence of sustainable diet characteristics in international food-based dietary guidelines (Jones et al., 2019).

Table 16.2. Thirteen countries and the elements of sustainable diets.

Country (year)	Visual representation	Promotes dietary biodiversity	Promotes plant-based diets	Moderate red meat consumption	Limit processed meat	Moderate dairy consumption	Encourages sustainable seafood consumption	Limit processed/ultra-processed foods	Water conservation in cooking	Promotes buying local foods/seasonal/most sustainable options	Encourages food and packaging waste reduction	Behavioural e.g. exercise/cooking etc.	Animal welfare?/under threat	Directly links diets to sustainability
Australia (2013)	Plate				X	X		X						
Brazil (2014)	NA	X	X	X	X	X		X		X				X
Canada (2007)	Rainbow				X									
China (2016)	Pagoda							X			X			
Estonia (2006)	Pyramid		X	X	X			X		X	X	X	X	X
France (2011)	NA							X		X				
Germany (2013)	Circle/disc		X	X			X				X	X	X	X
Netherlands (2015)	Wheel of Five		X	X	X	X	X	X		X	X			X
Qatar (2015)	Oyster		X	X	X		X	X	X	X	X			X
Sierra Leone (2016)	Plate				X			X		X				
Sweden (2015)	Traffic light		X	X	X	X	X	X		X			X	X
UK (2016)	Plate			X	X	X	X	X						X
USA (2016)	Plate													

Immediate action to create sustainable food systems is imperative if current and future generations expect to continue to utilise the food systems and lifestyles currently taken for granted. However, a wealth of literature suggests that no country currently meets basic dietary needs for its citizens at a globally sustainable level of resource use (Perignon et al., 2016; Behrens et al., 2017; O’Neill et al., 2018). The gap between awareness and action suggests that there are opportunities for cooperative problem solving between all stakeholders of the global food system—the health, agricultural and environmental sectors—to arrest the rising tide of malnutrition and environmental degradation.

In line with international trends, New Zealand’s (NZ) food production and consumption patterns are driving many adverse health and environmental changes (OECD, 2017b). New Zealand has the fifth highest rate of contribution to climate change per capita in OECD countries (OECD, 2017b). Although NZ has an enviable reputation for the efficient production of comparatively large amounts of food for its population size, NZ’s current growth model is reliant upon emissions-intensive agricultural exports. Dietary choices are the leading modifiable risk factor contributing to ill-health and premature death (MOH, 2011, 2015; Tobias, 2016; OECD, 2017b). NZ currently has the third highest rate of overweight and obesity for adults and children within Organisation for Economic Co-operation and Development (OECD) countries (Tobias, 2016).

Although defining, measuring and evaluating a healthy diet with lower environmental impact is not straightforward, when the findings of New Zealand’s Adult Nutrition Survey 08/09 are compared directly to the nutrition indicators of sustainability proposed by Donini et al (2016), we find several discrepancies;

Firstly, in NZ, the ‘Bread’ group was the single largest contributor of protein to the diet (11%). This was followed by poultry and milk (each 9%), beef and veal (8%), grains and pasta and bread-based dishes (each 7%), fish and seafood (6%) and pork (5%). There was little intake of nuts, legumes or other plant-based protein alternatives. Specifically, an average of only 1.05% of protein intake came from nuts and seeds across all genders and ages.

The ‘Bread’ group was also the principal source of energy, contributing 11%, followed by grains and pasta (7%) and potatoes, kumara and taro (6%); fruit, non-alcoholic beverages, milk, bread-based dishes and alcoholic beverages each contributed 5% and sugar and sweets and poultry each contributed 4%. The total population energy source from vegetables was only 3.8% with three-fifths (59.3%) of males and 72.2% of females reported eating three or more servings of vegetables each day. Only

54.6% of males and 65.8% of females reported eating two or more servings of fruit each day. These statistics of the biochemical characteristics, quality and diversity of NZ's diet suggest unsustainable dietary patterns.

Further, New Zealand's mean body mass index (BMI) was 27.6 kg/m² for both males and females. From 1997 to 2008/09 there was an increase in mean BMI in both males and females. The New Zealand Health Survey 2017/18 found that: around 1 in 3 adults (aged 15 years and over) were obese (32%), around 1 in 8 children (aged 2–14 years) were obese (12%) and increasing. Furthermore, 33.7% of New Zealand's population were classified as being moderately food secure, and 7.3% were classified as having 'low food security'. These diet-related morbidity/mortality statistics and nutritional anthropometry statistics also suggest unsustainable dietary patterns.

When compared to *The EAT-Lancet Commission* global planetary health diet, New Zealand's population consumes less fruit, vegetables, nuts and legumes than recommended. Additionally, more sugar, saturated fat and, processed meat is consumed than suggested. Carbohydrate consumption, which in New Zealand consists of a median daily intake of 278 g of carbohydrate for males and 207 g for females, was close to the report's recommendations however, much of this consumption consists of processed foods. For example, whole-grain bread (heavy or light grain) was only chosen most often by 60.4% of males and 65.9% of females. Excluding bread, New Zealand's protein intake relies on animal sources more than plant sources and vitamin and mineral intakes in some age groups, including Vitamin A, B, Zinc and Selenium were less than optimal.

Lastly, many of the sustainability characteristics for potential inclusion in food-based dietary guidelines, based on inclusion in international FBDGs, are not featured in New Zealand's 2015 Eating and Activity Guidelines for New Zealand Adults. Under the adoption of the Paris Agreement, alongside 194 other countries, NZ committed to reducing greenhouse gas emissions to 30% below 2005 levels by 2030 (UN, 2015b). One simple step, both internationally and in NZ, in reaching these targets and shifting towards more sustainable diets, is for countries to develop or revise their FBDGs to include recommendations related to the impact of diets on ecosystems and natural resources. Dietary guidelines are a cost-effective and accessible way to guide public food choices and government policy changes.

According to the Food and Agriculture Organization (FAO) (2018), the intention of FBDGs is to promote overall health and prevent chronic diseases. In addition, FBDGs establish a basis for public food and nutrition, health and agricultural policies, and nutrition education programmes. To reflect these multi-sectoral requirements, effective guidelines must incorporate cooperation among multiple, key stakeholders (Magni et al., 2017).

However, a dichotomy has developed in most countries where the production, distribution and consumption of food is established by food policy, while population health through good nutrition is solely established by nutrition policy. FBDGs have been historically developed by the health sector and presented to the public and other sectors, without multi-sectoral collaboration and, with little or no consideration of sustainability issues (Fischer and Garnett, 2016).

More recently, in select governments, with heightened awareness of environmental issues, a more holistic, and country-specific, view has been applied to FBDG development and implementation (Fischer, Garnett., 2016; Jones et al., 2019). Maturing from other fields of study, the mutually dependent relationships between nutrition, human health and planetary health are being recognised and brought into nutrition policies and programmes, and the first modern examples of sustainable FBDGs are being produced.

Although countries have begun incorporating sustainability characteristics into their national dietary guidelines, they are moving at different rates in implementing these changes due to several challenges; namely, sectoral lobbying, opposition and over- and under-representation of certain stakeholders. For example, scientific committees in both the US and Australia have attempted to include environmental considerations in their respective FBDGs (Merrigan et al., 2015). However, due to a lack of government endorsement, and negative response and resistance towards their

implementation from a range of sectors and bodies, the most recent revisions of guidelines do not explicitly include sustainability characteristics in the body text. Sustainability guidance was only included in an appendix of the 2013, Australian Dietary Guidelines.

A shift towards sustainable dietary practices can raise several challenges for food system stakeholders (Metcalf et al., 2009; OECD, 2017b). Adverse reactions towards sustainable dietary practices drive the number of barriers faced by governments during attempts to implement sustainable characteristics in FBDGs. For example, a widespread dietary shift toward greater incorporation of plant-based foods and a reduction in animal-based products viewed as “drastic and unrealistic” by primary industry stakeholders (Sabate and Soret, 2014). Consequently, political influence, often through industry trade associations, has been used to block or reverse policies that would make the food system more sustainable.

In contrast, countries including Brazil and Sweden have begun to incorporate a wider range of expertise and representation in their FBDG consultation and development processes. This multi-sectoral approach, alongside transparent policy development tailored to the specific political, economic and social environment of each region, has allowed for successful and meaningful development and implementation of sustainable FBDGs (Burlingame, B., 2019; Fischer, Garnett., 2016; Jones et al., 2019). For example, the 2014 Brazilian FBDGs have included representation from the education, social welfare and agriculture sectors, as well as the public (MOH, B. 2014). This strategy has ensured the broader societal and environmental issues are addressed and included. It also ensured the generic characteristics of a sustainable diet are understood by those it is targeting by including them in the translation process.

The Eating and Activity Guidelines for New Zealand Adults were last updated in 2015 (Ministry of Health 2015). However, as many of the sustainability characteristics defined in Figure 1 do not currently feature in New Zealand’s guidelines, this provides an opportunity to address sustainability issues. The EAGs currently do not include explicit sustainability objectives, although interest in doing so appears to be growing within the Ministry of Health (MOH), making the inclusion of sustainability characteristics within the new EAGs plausible. Dietary guidelines are an essential and integral component of NZ’s national food policy. With public interest in climate change and health co-benefits increasing, this development may provide a greater incentive for the public to follow the recommendations and provide the government with an opportunity to take a progressive stance on this issue (Drew, 2018).

Given NZ’s current health and environmental status and commitments to reduce greenhouse gas emissions, not only must sustainability characteristics be incorporated in FBDGs but, this must be done in a meaningful manner. Therefore, the successes and challenges faced by other countries must be used as learning tools to guide development and implementation. If these lessons are ignored, there is a chance for attempts at implementation in NZ, as seen in America and Australia, to be abandoned. The successes observed in sustainable FBDG development and implementation around the world indicate that, alongside the health sector, all stakeholders must be included in the process. Multi-sectoral support for change is imperative. However, in order to employ a multi-sectoral approach, the attitudes and opinions of sectoral professionals must first be assessed.

To the best of the researcher’s knowledge, there are no studies specifically reporting sectoral professionals’ attitudes or opinions towards proposed, or implemented, sustainability recommendations for inclusion in FBDGs.

Purpose of the Study

The overall purpose of this study is to provide more evidence to inform the development and implementation of future inclusion of sustainability recommendations in New Zealand’s (NZ) eating and activity guidelines (EAG). Research to access and evaluate these opinions is an important step in NZ’s short- and long-term plans to develop cohesive guidelines in line with the UN’s Sustainable Development Goals.

Although it may be at first challenging to bring together the different opinions of multiple sectors and has the potential to slow down the implementation of guidelines, this inclusive process is essential, for both pragmatic and democratic reasons, and will likely increase the long-term success of guideline development (Sterling et al., 2017).

Findings will also contribute to the scientific basis guiding successful public health action which, if applied, may positively affect the quality of life of individuals, the environment and the future sustainability of NZ (Gupta et al., 2015).

Secondly, feedback prior to the implementation of the guidelines may avoid unnecessary conflict, ensuring all stakeholders are well informed and provide higher quality decision-making processes. Multi-sectoral participation has also been shown to increase stakeholders' support of potential change as well as increasing trust from the community (Sterling et al., 2017).

Lastly, in addition to paving the way for sustainable FBDGs in NZ, learnings gained from research regarding multi-sectoral opinions may improve communication between sectors and allow NZ to become an international leader in the research and implementation of developing tailored, comprehensive, population-based, integrated, multidisciplinary and multi-sector approaches to sustainability, offering practical information to inform successful implementation of sustainability characteristics within NZ's EAGs (FAO, 1998).

Aims and Objectives

Aims

To evaluate attitudes towards inclusion of sustainability characteristics within New Zealand's eating and activity guidelines (EAGs) by professionals in the agriculture, environment and health sectors.

Objectives

1. Identify characteristics of a sustainable diet from literature.
2. Design and disseminate an online survey to ascertain the level of agreement that agriculture, environment and health sectoral professionals of New Zealand hold towards the inclusion of sustainability characteristics within NZ's EAGs.
3. Evaluate the divergence and convergence of agreement between sectoral groups towards the inclusion of sustainability characteristics within NZ's EAGs.

Hypothesis

There will be no statistically significant level of convergence between the level of agreement agriculture, environment and health sectoral professionals of New Zealand hold towards the inclusion of sustainability characteristics within NZ's EAGs.

Structure of Thesis

Chapter 1 introduces this study by outlining aims and objectives and providing research justification.

Chapter 2 is a review of related literature, covering the background and key concepts, such as sustainable diets, food-based dietary guidelines (FBDGs), New Zealand's food system and eating and activity guidelines, as well as international challenges and successes of including sustainability characteristics into FBDGs.

Chapter 3 shows the results of the study investigating multi-sectoral attitudes towards introducing sustainability characteristics into NZ's dietary guidelines. Chapter 3 is presented as a generic manuscript for publication; however, it is formatted to meet the requirements of *Frontiers: Nutrition and Environmental Sustainability*. Lastly,

Chapter 4 includes a brief overview of the achievement of the aims and objectives of this study, explores the impact and contributions of this research, discusses study strengths and limitations and provides final recommendations from this study.

Supplementary appendices include additional background methods and study protocol, statistical analyses on multi-sectoral attitudes towards introducing sustainability characteristics into NZ's dietary guidelines and a copy of the questionnaire.

Contributions of Researchers

Researcher	Contribution
Rebekah Jones MSc Nutrition and Dietetic Student	Primary author of this thesis and responsible for all aspects of this study, including research proposal, literature review, ethics application, study design/questionnaire development, liaising with key stakeholders, data collection, statistical analysis and preparing the final manuscript.
Prof Barbara Burlingame Academic supervisor	Supervision of the entire research process through to final submission. Assisted with the research question, study design and questionnaire development. Assisted with the editing, finalising and submission of all thesis chapters and manuscript.
Associate Professor Carol Wham Academic supervisor	Supervision of the entire research process through to final submission. Assisted with ethics application and questionnaire development. Assisted with editing, finalising and submission of all thesis chapters and manuscript.
Dr Kathryn Beck	Assisted with statistical analysis.

Chapter 2: LITERATURE REVIEW

Sustainable Diets

The United Nations Food & Agriculture Organization (FAO) defines sustainable diets as “*those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimising natural and human resources*” (FAO, 2010, p. 1).

A wealth of literature suggests that no country currently meets basic dietary needs for its citizens at a globally sustainable level of resource use (Perignon et al., 2016; Behrens et al., 2017; O’Neill et al., 2018). Including New Zealand, human dietary patterns, both current and emerging, threaten human and environmental health (Lang et al., 2009; Burlingame and Dernini, 2012; Alsaffar, 2016; Fischer and Garnett, 2016; Candel and Pereira, 2017).

Enabled by the past century’s economic, technological and social developments, international dietary trends are increasingly characterised by foods with poor nutritional quality and high caloric content (Marteau et al., 2015; Scott, 2017). The prevalence of highly processed and animal-based foods, as well as inadequate fruit, vegetable, fibre and essential micronutrient intake, have resulted in human and planetary health degradation. This shift in dietary patterns over time has been referred to as the “nutrition transition” (Kearney, 2010).

Food System and Human Health

Non-communicable diseases, including diabetes, coronary heart disease and certain types of cancer, are now prevalent in both high and middle-income countries (Popkin, 2003; Speedy, 2003; Schmidhuber and Shetty, 2005; Popkin et al., 2012; Hallegatte et al., 2015; Scott, 2017). In 2016, more than 1.9 billion adults aged 18 years and older were overweight; of these, over 650 million adults were obese. Further, an estimated 41 million children under the age of 5 years were overweight or obese (Popkin, 2006; WHO, 2018), with micronutrient malnutrition affecting all weight/body mass groups (WHO, 2018). These statistics are directly linked to the nutrition transition and contribute to the leading risk factors of the global burden of disease (McCarthy et al., 2001; Searchinger et al., 2014; Stanaway et al., 2018).

Food System and Environmental Health

All stages of food production, including primary production, manufacturing, storage, food preparation and consumption, impact the environment. Modern processes of the food system have led to unparalleled and potentially irreversible negative environmental impacts (Steffen et al., 2015a; Steffen et al., 2015b; Whitmee et al., 2015). These include deforestation, greenhouse gas emission, damaged ecosystems, depleted fish stocks, soil degradation, heavy water footprint and loss of biodiversity (Ramankutty and Foley, 1999; Steinfeld et al., 2006; De Fraiture et al., 2010; Tilman and Clark, 2014; Springmann et al., 2016; Clark and Tilman, 2017; IUCN, 2018).

Not only does the food system affect the environment, the food sector—the very system diminishing the environment’s capacity to provide nutritionally adequate food—is affected by environmental changes (Reynolds et al., 2015). For example, the food sector accounts for around 30% of the world’s total energy consumption and accounts for around 22% of total greenhouse gas emissions (Garnett, 2011). At the same time, the environmental impacts of this output increase the risk of crop failure (Parry et al., 2004). Consequently, inequities in food access and decreases in affordability and availability, are becoming prevalent (Friel et al., 2008).

Growing Awareness

Nutrition and sustainability are high priority on the global political agenda (WHO, 2017; Monteiro et al., 2018; Jones et al., 2019). The most recent *Intergovernmental Panel on Climate Change (IPCC) report* re-emphasises that the food sector and specifically, livestock, is by far the biggest contributor to dietary greenhouse-gas (GHG) emissions. A tightened recommended safe limit for global warming increase to no more than 1.5°C by 2050, has been applied in an attempt to prevent catastrophic

consequences of extreme weather conditions including heat, droughts, floods, and poverty (IPCC, 2018a; b). Specific to nutrition, the United Nations (UN) IPCC recommendations include the consumption of less meat and dairy, to throw less food away and to buy more locally sourced, seasonal foods. The UN General Assembly declared the period 2016 to 2025 as the Decade of Action on Nutrition. The importance of nutrition and dietary shifts is further reflected in the 17 UN Sustainable Development Goals (SDGs); in particular, Goals 2 (“end hunger, achieve food security and improved nutrition, and promote sustainable agriculture”) and 12 (“responsible production and consumption”) (UN, 2015c). In addition to policy drivers, there has been growing public and academic awareness of how eating habits simultaneously impact on human and planetary health (Fischer and Garnett, 2016). Scientific literature highlights that sustainable diets can be synonymous with healthy diets (Fischer and Garnett, 2016). In line with global dietary guidelines from both the World Health Organization and the World Cancer Research Fund, it has been suggested that reducing animal-based food intake and increasing consumption of plant-based foods could, by 2050, reduce global mortality by as much as 10%, and food system-related emissions by between 29% and 70% (Pimentel and Pimentel, 2003; Garnett, 2011; Scarborough et al., 2014; Tilman and Clark, 2014).

In response, the scope of nutrition, dietetics and public health is extending from conventional biological foundations to include social and environmental dimensions (Beauman et al., 2005). Terms such as ecological public health (Rayner and Lang, 2012) and environmental nutrition (Sabate et al., 2016) are being used to describe the ways in which diets can act as fundamental determinants of public health directly, through their impact on nutrition, and indirectly, through their impact on the environment. Only through this new, holistic, way of thinking can SDGs 2 (“end hunger, achieve food security and improved nutrition, an promote sustainable agriculture”) and 12 (“responsible production and consumption”) be achieved.

Addressing the unsustainability of the food system is no small task; however, the consequences of no action are a far greater burden. A shift in current dietary patterns to ones that provide for both human and planetary health will require a myriad of effective and interconnected policies, scientific and socioeconomic advances, farmer ingenuity and public engagement (Lang et al., 2009).

Food-based Dietary Guidelines (FBDGs)

Food-based dietary guidelines have been historically based on country-specific, diet-related morbidity and mortality. However, as the environmental impacts of food consumption and production push planetary boundaries, the case for inclusion of elements of environmental sustainability into FBDGs becomes compelling (Fischer and Garnett, 2016).

A myriad of scientific evidence, scattered throughout the history of FBDGs, exists which cite the need for the development and implementation of sustainable dietary practices. In 1986, Gussow and Clancy published *Dietary Guidelines for Sustainability*, in which they argued that information must stem from multiple disciplines including medical, economics, agriculture and environmental science (Gussow and Clancy, 1986).

In 1987, the era of sustainable development was hastened by the 1987 UN report, *Our Common Future*, also known as *The Brundtland Report* (Brundtland, 1987). This sustainable development framework recognised both present and future generations, and the equal importance of people and planet. However, for the most part, FBDG development did not reflect these issues (Burlingame and Dernini, 2012). The Brundtland (1987) report did, however, inform the processes of developing a definition of a sustainable diet stated above (Burlingame and Dernini, 2012; Waterlander et al., 2018).

By the end of the 20th century, more than 100 countries presented FBDGs. These were published as food guides, posters, and infographics, often depicting food pyramids, food plates, and other symbolic representations (Burlingame., 2014;). They successfully provided a framework for nutrition education programmes and informed policies in health and agriculture. However, sustainability recommendations were, for the most part, still absent (Burlingame and Dernini, 2012).

The Convention on Biological Diversity (CBD), a multilateral treaty, put forward a framework and rationale in its 2004 Conference of the Parties as to how human nutrition can play a key role in the

conservation and sustainable use of food biodiversity (Groombridge, 1992; CBD, 2006; Toledo and Burlingame, 2006). One of the recommendations featured in this decision directly addressed FBDGs, stating the importance of “integrat[ing] biodiversity concerns into nutrition instruments, *inter alia*, food-based dietary guidelines” (CBD, 2006, p. 5). Furthermore, it stated that this integration must be “scaled upwards to address a more global, cross-sectoral agenda, without losing local and cultural specificities” (CBD, 2006, p. 3).

In 2010, the Food and Agriculture Organization of the United Nations (FAO) and Biodiversity International convened The International Scientific Symposium, *Biodiversity and Sustainable Diets: United Against Hunger* (Burlingame and Dernini, 2012). One of the outcomes of the symposium was a consensus definition of a sustainable diet. This symposium leveraged the expertise of key stakeholders from civil society, government, and the private sector to develop the evidence base to provide directions and solutions for policy, research and action (Burlingame and Dernini, 2012).

During the final session of the Symposium, a consensus Platform for Action was presented and endorsed. Article five in the platform states the following:

Food-based dietary guidelines and policies should give due consideration to sustainability when setting goals aimed at healthy nutrition. A guidance document on how to develop such guidelines and policies at national level could be elaborated by FAO, in collaboration with Biodiversity International and other partners (FAO, 2010, p. 2).

This recommendation was addressed and finally achieved in 2016 with the joint FAO and Food Climate Research Network report, *Plates, pyramids, planet. Developments in national healthy and sustainable dietary guidelines: a state of play assessment* (Fischer and Garnett, 2016). The *Plates, pyramids, planet* report provides a clear guide on what dietary patterns look like that are simultaneously good for human health and environmentally sustainable, along with an in-depth review of how countries were currently incorporating sustainability into their FBDGs (Fischer and Garnett, 2016). The report highlights how FBDGs can form the basis of policy development, aiding the shift to more sustainable food systems. The overarching recommendation from this report was for countries with existing FBDGs to consider a way of incorporating sustainability recommendations into them and that those countries without FBDGs are in a unique position to develop integrated guidelines from the outset (Fischer and Garnett, 2016).

The report identifies that, as there are myriad stakeholders from the health, agricultural and environmental sectors involved in the food system and its impact on both human and planetary health, they must all be considered as key players in helping inform what determines dietary advice for each country. Only by linking health, dietary guidance, agriculture and the environment can human health, the sustainability of natural resources and current and long-term food security be ensured.

Introducing sustainable eating patterns into food-based dietary guidelines is now widely recognised as a convenient and efficient strategy to align nutrition policy with related global and national food and agriculture policies (Burlingame and Dernini., 2012; CBD., 2006). FBDGs are an appropriate medium for affecting the way people eat and, consequently, their impact on food and environmental systems. They can be used to create awareness of how consumers’ food purchasing behaviours affect the environment (Oshiro et al., 2018).

New Zealand

In line with international trends, New Zealand’s food production and consumption patterns are driving many adverse health and environmental changes (OECD, 2017a). As the effects of climate change are likely to increase over time, so too will the adverse effects on the population’s health, agricultural and environmental sectors (Woodward et al., 2001; Metcalfe et al., 2009; Bennett et al., 2014). Consequently, the case for the inclusion of environmental considerations and sustainability characteristics into FBDGs has become compelling.

NZ: Dietary Trends

In line with international trends, New Zealand diets now generally consist of the consumption of excessive saturated fat and sodium and inadequate dietary fibre, compared to national guidelines (MOH, 2011; 2015). As in many developed countries, meat is the dominant dietary component of many New Zealanders' diets and is viewed as a commodity, where economic profit is a major objective of its production rather than being seen primarily as a source of nutrition and health benefits (Grivetti and Ogle, 2000; Bharucha and Pretty, 2010; Magdoff, 2012).

When the findings of New Zealand's Adult Nutrition Survey 08/09 and New Zealand Health Survey 16/17 are compared to the nutrition indicators of sustainability proposed by Donini, et al (2016) we find that New Zealand dietary trends do not follow many of the sustainable diet indicators. Specifically, plant and animal protein consumption ratios are skewed towards animal sources, dietary energy density scores are high, nutrient density of diet and foods are low, fruit and vegetable consumption is very low and New Zealand diets do not adhere to the Mediterranean dietary pattern (Donini, et al., 2016).

NZ: Human Health

As described by Donini et al (2016), clinical aspects including diet-related morbidity/mortality statistics and nutritional anthropometry can act as indicators of the sustainability of a population's diet.

In NZ, chronic diseases contribute 88% of the current national burden of ill-health (Tobias, 2016). The most recent NZ health survey states that diet, excess weight and physical inactivity are three of the top five risk factors contributing to "health loss" in New Zealand. These are most commonly attributed to cardiovascular disease, cancers, diabetes and musculoskeletal disorders (Parnell et al., 2011).

Growing rates of obesity and associated non-communicable diseases contribute to a significant health burden on individuals, families and the nation. Productivity loss and the direct health care costs are also increasing. Annually, between NZ\$722m and NZ\$849m is estimated to be spent on the effects of overweight and obesity (Lal et al., 2012). As per Donini et al (2016)'s indicators of a sustainable diet, these statistics suggest that New Zealand diets are unsustainable.

NZ: Environmental Health

New Zealand (NZ) is already experiencing adverse environmental impacts, with more change expected in line with international trends (Metcalf et al., 2009; Hollis, 2014; Rockström et al., 2016; MfE, 2018). The current growth model in NZ is reliant upon emissions-intensive agricultural exports and is nearing its environmental limits (OECD, 2017a). Although NZ is a small emitter in absolute terms, accounting for less than 0.2% of global emissions, its food system is a major contributor to climate change. Per capita, NZ's emissions are the fifth highest among Organisation for Economic Co-operation and Development (OECD) countries in 2011 (OECD, 2017a).

Of specific concern is the paradox that NZ's food system relies heavily on, yet depletes, its natural resources. More than 60% of NZ's gross domestic product (GDP) is provided by the agricultural sector despite nearly 90% of the population living in urban areas. NZ is already counted among the world's most efficient agricultural producers, with research funding into technologies aimed at reducing supply-side emissions (e.g., per unit of land, animal or product) set to expand (UN, 2015a). Despite this, half of NZ's greenhouse gas emissions come from the agricultural sector, the highest share in the OECD (OECD, 2017a). The total direct energy use on farms has doubled between 1990 and 2014, placing further pressures on the environment (MBIE, 2014). Although the export value of all primary food products is almost \$30 billion NZD per annum, representing over half of our total export earnings, export of New Zealand primary food products consumed around 16PJ of Heavy Fuel Oil in 2007, which accounts for approximately 25% of the energy used to export all New Zealand products (StatsNZ, 2016; Fitzgerald, Howitt, Smith 2011). Around 70% of these food exports also require some form of climate control during distribution, which can add an additional 20% to the total amount of direct energy consumed during transportation (Fitzgerald et al, 2011). This is an area of

vulnerability for New Zealand as, due to reliance on fossil fuel inputs, is vulnerable to oil price variability, carbon prices, potential for new market access barriers and changing consumer preference for clean, ‘carbon free’ products. In addition, the forests store a large quantity of carbon which prevents it from collecting in the atmosphere and reduces the net emissions profile (Leining, 2015).

What type of produce—and how much—NZ’s agriculture sector can grow or harvest, both on the land and in the sea, have been shown to be changing. Increasingly unpredictable weather cycles have been shown to result in some years becoming more, or less, productive and some regions will become better suited to growing crops and producing goods than others. Increased rainfall can result in erosion and increased sediment in waterways and soil loss can damage the stability of land and reduce its productivity, and the variety of pests and diseases the country is vulnerable to could change. A 2013 analysis prepared for the Ministry of Primary Industries showed that under a high-end warming scenario (4.4°C average temperature increase by 2100), there would be a significant decline in dairy pasture production, along with increased dairy cow heat stress in many dairying areas of NZ (Bennett et al., 2014). Further, as ocean temperatures and acidity continue to rise, fish populations and subsequently commercial fish stocks are also at risk (Phillips and Pérez-Ramírez, 2017; Hollingsworth, 2018).

More controversially, increased waste production has been attributed to over-consumption of low-nutrient, energy-dense foods, which tend to be highly processed and packaged, furthering adverse socio-economic and environmental effects (Gustavsson et al., 2011; Friel et al., 2014; Garnett et al., 2014).

Summary of the NZ Dietary Situation

Overall, trending dietary practices in New Zealand (NZ) are not sustainable for the health of the individual or the environment (Donini et al., 2016; MOH, 2011; 2015). As the effects of climate change expand, health burdens on both humans and the environment will increase. In most regions, food and water availability will reduce and food prices are set to increase. Many locally produced and imported food staples in NZ will be affected. The ability of some groups to afford a variety of nutritious foods will be reduced, further compromising their nutritional outcomes (Parnell et al., 2001; Husband, 2013; Smith et al., 2014). These will disproportionately affect populations that already experience socio-economic disadvantages (Bennett et al., 2014).

In transitioning toward a more sustainable economy and, with the aim of reducing its global greenhouse gas concentrations (McCarthy et al., 2001), a key priority will involve continuing to make alterations within the agricultural and food sectors. However, while supply-end strategies, when implemented widely, have the potential to lead to important emissions reductions (Fischer and Garnett, 2016). However, the potential to reduce emissions arising from within the supply chain is not nearly as significant as those that can be achieved through a demand-end approach: namely, decreasing consumption of those agricultural products that are GHG-intensive (Hollis, 2014).

New Zealand’s Obligations

Given that the food system is a primary driver of detrimental change to the earth system and that the burden of nutrition-related chronic disease continues to grow around the world, the importance of focusing research and policy efforts on healthy and sustainable eating patterns is incontestable (Quiggin, 2010; Drew, 2018).

Under the adoption of the 2015 Paris Agreement, alongside 194 other countries, New Zealand (NZ) committed to reducing greenhouse gas emissions to 30% below 2005 levels by 2030 (UN, 2015b). Further targets in place for the future include a target to reduce its net GHG emissions to 5% below 1990 gross emission levels by 2020 under the United Nations Framework Convention on Climate Change (UNFCCC), whilst maintaining a conditional 2020 target pledge of a 10% to 20% reduction below 1990 levels. Further, the government set a 2050 target to reduce net GHG emissions to 50% of gross 1990 emissions (MfE, 2017).

As a high, and growing, per-capita greenhouse gas emitter (Heilig, 2012; MfE, 2013; DESA, 2015), NZ has a responsibility to increase its own ambitions with respect to greenhouse gas emission reductions through a series of equitable and holistic approaches. To reach these targets, policies that are directed toward the public should provide information and incentives that stimulate movement toward sustainable living and consumption (Hales et al., 2000; Bennett et al., 2014).

Despite the growing number of people interested in sustainable diets and reducing meat consumption, as mentioned above, many still show general ambivalence to the environmental impact of their food. Research by UK-based Chatham House indicates that many people are not aware of the environmental impact of meat/livestock production, especially compared with other protein sources (Wellesley et al., 2015; Macdiarmid et al., 2016).

Innovative and creative solutions are needed to help NZ's food system to be more sustainable (McCarthy et al., 2001; MfE, 2014). Fortunately, evidence is mounting that sustainable diets can be realised, which maintain nutritional adequacy and affordability, along with acceptable environmental impacts. Evidence suggests that such a shift would contribute to NZ's obligations contained in the Sustainable Development Goals, the Decade of Action for Nutrition, and many other international instruments agreed, ratified and endorsed by almost all countries in the world.

By 2050, sustainable dietary shifts, including a reduction in animal protein intake and a reduction of unnecessary food waste, on an international scale, could reduce global mortality by as much as 10%, and diet-related emissions by between 29% and 70% (Springmann et al., 2016). These dietary recommendations are in line with global dietary guidelines from both the World Health Organization and the World Cancer Research Fund.

As an essential and integral component of NZ's national food policy, the inclusion of sustainability characteristics within the new dietary guidelines is plausible. With international public interest in the link between nutrition, the environment and the food system increasing, this development may provide a greater incentive for the public to follow the recommendations and provide the government with an opportunity to take a progressive stance on this issue (Springmann et al., 2016; Drew, 2018; Jones et al., 2019).

Current FBDGs in New Zealand

Currently, the Ministry of Health has funded and published food and nutrition guidelines for different population groups along the life course: adults, pregnant and breastfeeding women, infants and toddlers (0–2 years), children and young people (2–18 years), and older people.

The Ministry of Health states that the aim of the *Eating and Activity Guidelines for New Zealand Adults* is to provide clear, evidence- and expert-based policy advice to the government, health sector and government addressing the issues of the day (MOH, 2015).

Accordingly, the guidelines clearly outline that eating well and being regularly physically active are essential for the overall health and wellbeing of all New Zealanders as well as reducing health loss (MOH, 2015). In line with WHO recommendations, eating, activity and body weight statements are included. However, without recognition of sustainability characteristics, it can be argued that all the pertinent issues of the day are not being fully addressed.

New Zealand's current Eating and Activity Guidelines for Adults do not currently include explicit sustainability objectives. The Royal Society Te Apārangi has identified a great need for further research into the relationship between climate change and human health in New Zealand and research has begun to develop sustainability statements fit for inclusion in NZ's EAG series, or within supporting documentation, based on GHG emissions (Apārangi, 2017; Drew, 2018).

Development of Sustainability Characteristics in NZ FBDGs

A range of possible sustainable diets exist, made up of several sustainable characteristics with each of the components of these diets contributing a different volume of environmental impact (Macdiarmid et al., 2012).

As discussed in the introduction, Figure 1 and Figure 2 (Jones et al., 2019) define, and provide rationale for, sustainable dietary characteristics common to many international FBDGs. The twelve general sustainability characteristics for potential inclusion in food-based dietary guidelines (FBDGs) have been identified based on their inclusion in international FBDGs (Jones et al., 2019); dietary biodiversity, plant-based diets, moderate/limit red meat consumption, limit processed meat consumption, moderate dairy consumption, encouraging sustainable seafood consumption, limiting processed and ultra-processed foods, water conservation in cooking, promotion of buying local and seasonal foods, encouraging food and packaging waste reduction, sustainable behaviours including exercise and cooking at home and animal welfare. These characteristics all contribute to both human and planetary health. Their presence in international FBDGs are described in Figure 2 (Jones et al., 2019).

Many of these characteristics have been introduced into national FBDGs worldwide. However, very little variation is seen internationally. Given other countries' attempts to implement these characteristics, it has been shown that these common sustainability characteristics must be tailored to the specific environment in which they are to be applied. In New Zealand, this means understanding how these characteristics can be translated into guidelines in a meaningful manner, in order to support its local health as well as social and economic drivers. Only in this way will public and professional sectors likely follow such recommendations (Wellesley et al., 2015; Jones et al, 2019).

Tailoring Guidelines to NZ

In line with international research, New Zealand research suggests that a diet consisting of whole plant foods, including vegetables, fruits, legumes, and whole grains, is found to be far less emissions-intensive than a diet consisting of mostly animal-based foods, particularly red and processed meats.

A NZ-specific database of GHG-emission estimates for each of the 341 food categories is now available (Drew, 2018). From this, it has been estimated that conforming to the current EAGs in combination with further emphasis on sustainable food choices can result in GHG emissions savings of up to 50% (Drew, 2018). Specifically, GHG emissions savings occur mainly via a reduction in animal protein intake and a reduction of unnecessary food waste at population level (Drew, 2018).

Implementation: Sustainability Characteristics in NZ's FBDGs

Internationally, governments are moving at different rates in developing sustainable FBDGs. This is partly due to not only controversy in defining what a sustainable diet looks like in practice, but a number of social challenges which governments face in their attempt to implement sustainability objectives (TWB, 2012).

The development of sustainable guidelines specific to New Zealand's environment, as well as their implementation and long-term success, requires an understanding of how these recommendations may be received by New Zealand stakeholders.

There is a dearth of research focusing on the implementation stage of new guidelines. The main purpose of the next part of this literature review is to present a coherent argument for how New Zealand may mitigate foreseeable challenges during future attempts to implement sustainability characteristics into the next series of EAGs.

Challenges

The food system is complex. Several social, economic and political interactions exist between people and their food. Consequently, development and implementation of meaningful FBDGs have always been associated with many challenges (Merrigan et al., 2015; NHMRC., 2013; Rutter et al., 2011). The recognition of the need to integrate the full suite of impacts that dietary choices and the food system can have on the environment has exacerbated these challenges (Jones et al., 2019).

Consequently, as first recognised by Glasgow and Clancy (1986), controversy has arisen from the development, implementation and promotion of sustainable diets (TWB, 2012). The root of many of these challenges has lain in the impact a shift towards sustainable dietary practices can have on stakeholders across several sectors which affect, and are affected by, the food system (Metcalf et al.,

2009; OECD, 2017a). Although health, environmental and humanitarian concerns are common to all sectors, differences lie in the degree to which each sector, and professionals within these sectors, perceive the importance of and viability of methods for addressing these issues as they try to achieve their own set of interests.

Many associated constraints surround a shift in agriculture production including employment, land use, technology and education. A recommendation to reduce the consumption and subsequent production of a food item in one sector may increase pressure to obtain food from another sector and vice versa (Blanchard et al., 2017). Therefore, opposing opinions are understandable, as proposed modified practices, to mitigate the impacts of climate change, can potentially have serious negative economic implications for many current practices.

The literature shows that, while eating pattern changes hold the potential to significantly reduce GHG emissions, the premise of a widespread dietary shift toward greater incorporation of plant-based foods and a reduction in animal-based products is viewed as “drastic and unrealistic” by many stakeholders (Sabate and Soret, 2014).

Many stakeholders have been seen to use their political influence, often through industry trade associations, to block or reverse policies that would make the food system more sustainable. As public policy raises the bar for entire industries, requiring that all stakeholders contribute to meet minimum standards, lobbying to block sound public policies such as sustainable FBDGs can outweigh sustainability initiatives.

Internationally, the development of FBDGs typically falls under the management of the ministries of health. The process is therefore driven and directed by the interests of health sector professionals and governing bodies. A lack of consultation with other sectors involved in the health and food system can often mean there is advocacy from powerful interests. Many national governments find that the pressure from private sector vested interests make it difficult to develop recommendations and guidelines which accommodate all sectoral needs. This has been shown to result in resistance, lobbying and subsequent abandonment of FBDGs that aim to include sustainability characteristics.

Scientific committees in both the US and Australia have attempted to include environmental considerations in their respective FBDGs (Merrigan et al., 2015). However, due to a lack of government endorsement and negative response and resistance towards their implementation from a range of sectors and bodies, the most recent revisions of guidelines do not explicitly include sustainability characteristics.

During the development of the Australian guidelines, public media campaigns strongly opposed incorporation of sustainability characteristics and recommendations. Advocated by the food industry, farmers and fisheries groups, the main argument raised was that the environmental concerns were beyond the mandate of the dietary guidelines. Consequently, sustainability guidance is only included in an appendix in the final version of the Australian Dietary Guidelines (NHMRC, 2013).

Similarly, the inclusion of environmental sustainability into the 2015 US Dietary Guidelines was heavily opposed by the food industry. In a joint statement to the press, the US Secretaries of Agriculture and of Health and Human Services stated: “We do not believe that the 2015 DGAs [Dietary Guidelines for Americans] are the appropriate vehicle for this important policy conversation about sustainability” and that the purpose of dietary guidelines was simply to educate the population about weight control and chronic disease prevention (DeSalvo et al., 2016).

Successes

Although not as dominant as the lobbying in the US, the debate regarding sustainability guidance in Swedish FBDGs continued for ten years before implementation. The biggest opposition came from the LRF Dairy Sweden, which claimed that it was too early for advice based on both human and planet health via FBDGs, due to the immaturity of research regarding the environmental impact from food production and the importance of milk as a food that naturally contains many important nutrients. The National Food Agency then included representatives from other governmental bodies,

such as the Public Health Agency and the Swedish Board of Agriculture, the food industry, and research centres. Although initially critical, the dairy organisations eventually did express their support for the ambition to incorporate environmental sustainability into the Swedish FBDG advice once they became engaged in their development and framed it as cultural messaging, tailored to Sweden specifically (Dahlbacka, B., Spencer, O., 2010; Livsmedelsverket, 2015).

From these examples, it becomes clear that, in high-income countries with large-scale agriculture sectors, specifically meat and dairy, the agricultural sector's attitudes and opinions towards sustainability recommendations carry significant influence in guideline and policy development and successful implementation.

In contrast, some governments have begun to incorporate a wider range of expertise and representation in their consultation and development processes of sustainability-focused FBDGs.

For example, the 2014 Brazilian food-based dietary guidelines included representation from the education, social welfare and agriculture sectors, as well as the public (MOH, 2014). This strategy ensured that the broader societal and environmental issues of the food system were addressed and included in the development and implementation processes. By including multiple perspectives in the development process, Brazil ensured that all recommendations were translated in a way that can be understood and followed by all stakeholders. This process has helped to mitigate resistance, lobbying and abandonment, and allowed for successfully developing and implementing FBDGs with sustainability at the forefront, supported by all sectors.

Learnings

Lessons must be learned from cases where formal national guidelines have successfully incorporated sustainability characteristics. Specifically, where development and implementation has survived lobbying pressures (Rutter, Marshal, Sims., 2011). One commonality is the prerequisite of a multi-sectoral approach. This suggests that, with facilitated consensus-building across the full spectrum of food system stakeholders, many of the barriers which surround the development and implementation of sustainable FBDGs can be overcome (Garnett, 2014).

As seen in America, Australia and Sweden, a negative attitude from stakeholders towards implementation results in lobbying and subsequent abandonment of proposed sustainable FBDGs. This suggests that stakeholders' attitudes towards the inclusion of sustainability characteristics before implementation can predict their response following implementation. This relationship, that attitudes have a correlation with future behaviour, has been widely studied and has been accepted as an overall theoretical framework (Ajzen., 1985, 1991; Glasman & Albarracín, 2006).

Therefore, in order to predict whether the inclusion of sustainability characteristics within NZ's EAGs will be supported by key stakeholders in NZ, it is essential to first identify existing attitudes. If a largely negative attitude towards sustainable characteristics and their inclusion exists, this may predict a negative attitude and subsequent behaviour, such as lobbying, to occur following implementation. This will also highlight and inform where changes to the development process may be required to elicit support such as strategies to extend a multi-sectoral approach to development and implementation (Albarracín, et al., 2003).

The use of a multi-sectoral approach is further supported by Kickbusch (2008), who identifies that a practical way to strengthen adaptation and mitigation efforts to prepare for, and respond to, the health effects of climate change is to incorporate health within all related sectoral policies (Kickbusch, 2008). Only appropriate engagement from all sectors in policy decisions, traditionally thought to be solely driven by a single sector, has been shown to be effective in changing environments (Bowen et al., 2014). This multi-sectoral approach reflects the multiple sectors affected by modern health and environmental concerns. Supporting such joint positions would lead to a greater understanding of mutually relevant issues, with positive outcomes for policy development and action, albeit after working through advocacy debate and conflict. In some contexts, strong partnerships already exist between health and other sectors, but local input on how these can be strengthened (paying attention to different contexts) is vital (Bowen et al., 2014).

Multi-sectoral Approach in New Zealand

In 2011, the NZ Ministry of Health undertook an evaluation process in which feedback was sought regarding how the guidelines were being used and how they could be improved to inform future development, distribution and promotion (MOH, 2015). This evaluation identified key stakeholders to provide feedback, including health practitioners, national organisations such as Dietitians NZ and colleges such as the Royal New Zealand College of General Practitioners (RNZCGP), Māori and Pacific public health nutrition and physical activity organisations, non-government organisations, physical activity and fitness organisations, food industry groups, government agencies and crown entities. Representatives from the environment, agriculture and public sectors were not included.

In 2013, a technical advisory group was established to advise the MOH on updating its population health guidelines. This most recent publication, *Eating and Activity Guidelines for New Zealand Adults* (MOH, 2015) was the first-time public consultation was included in the revision process. In addition, to update the guidelines for adults, the Ministry and the Technical Advisory Group considered the latest evidence reviews from similar countries and international organisations to guide the development process. The national dietary guidelines of Australia, the United States and Nordic countries were all included (MOH, 2015). Still no agriculture or environmental stakeholder considerations were included.

Without adequate representation from the agriculture sector, it is likely to be more difficult to achieve climate goals. It is now recognised that continuing to rely on GHG-intensive livestock production is at odds with achieving NZ's commitments to the Paris Climate Agreement, and that this lack of input can unfairly burden other sectors (OECD, 2017b; Drew, 2018).

Well-designed policies can reduce the negative health impacts of climate change while improving population health. Everyday dietary choices have been shown to be among the most effective ways in which individuals may reduce their personal climate footprint (Joyce et al., 2014; Apārangi, 2017; Wynes and Nicholas, 2017). Sustainable actions, including FBDG policy development, requires intersectoral collaboration for success. Therefore, sectoral professionals involved in the process must be identified and included in the development of FBDGs;

Firstly, nutrition policy development has always been led by the health sector therefore their support and input are essential. Secondly, as the era of industrial agriculture emerged, the agriculture sector has become the second most influential sector involved in food policy and, right or wrongly, holds much of the blame for environment problems. Lastly, the environment sector is, now more than ever, an important partner sector for nutritional policy development (Burlingame, 2014). Including these three sectors are fundamental to understanding.

Challenges facing successful implementation of sustainable characteristics into FBDGs has been associated with the opinions of individuals at all levels, spanning all sub-sectors within the agriculture, environment and health sectors. Therefore, successful policy development must ascertain support from all individuals, at all levels. Recruiting participants from each level of the sectors, from entry and labour roles to senior management level roles, spanning all sub-sectors, is vital to the success of this research. This model is how consensus is gained within the UN system, for example, for the World Health Assembly.

To do so in New Zealand, the *Business Demography Statistics: Geographic units by region and industry 2000-18* (StatsNZ, 2016) was used to determine which individuals belonged to the three sectors.

Chapter 3: MANUSCRIPT

New Zealand's Food System is Unsustainable: A Survey of the Divergent Attitudes of Agriculture, Environment and Health Sector Professionals Towards Eating Guidelines

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Keywords: sustainability, attitudes, food-based dietary guidelines, agriculture, environment, health, professionals, sectoral

Abstract

Abstract

Background: The United Nation's Sustainable Development Goals (SDG) address the health and environmental changes needed for improving food and nutrition security. In one of its many sustainable development initiatives, the Food and Agriculture Organization of the UN (FAO) has called for sustainable diets, which align with SDG 2, Zero Hunger, and SDG 12, Sustainable Consumption and Production. The inclusion of sustainability characteristics in New Zealand's (NZ) eating and activity guidelines (EAGs) would contribute to directly addressing the SDGs and lead to achieving sustainable diets. This study aimed to evaluate the agreement among sectoral professionals for including sustainability characteristics within the guidelines.

Methods: Professionals of the agriculture, environment and health sectors were invited to complete an online survey to establish agreement with sustainability characteristics. Opinion and attitude questions were completed using a 5-item Likert scale. Responses were analysed in SPSS 25 (2017). One-way ANOVA analyses were conducted to compare the level of agreement and to detect a difference in means of the sector levels of agreement whilst controlling for covariates. Post-hoc tests were used to determine specifically where the significant differences lay among the sectors.

Results: Overall, 298 (65% female) respondents completed the survey from the agriculture (37%), environment (22%) and health (41%) sectors. Two-thirds (66%) of respondents were over 35 years and 90% had a tertiary education. Two-thirds (63%) of respondents disagreed with the statement that NZ's current food system is sustainable; health (77%) and environment (78%) sector respondents had greater disagreement with the statement than did those from agriculture (35%) ($P = 0.00$). Overall, 77% of respondents agreed that sustainability characteristics should be included in guidelines; health (90%) and environment (84%) sector respondents had greater agreement than those from agriculture (58%) ($P = 0.00$). Five of the sustainability characteristics received unanimously high levels of agreement ($> 90\%$) for inclusion: dietary diversity (97%), sustainable seafood (90.8%), to limit processed foods (90.7%), reduced food waste (95.3%) and sustainable lifestyle behaviours (97.2%). Agreement for eight sustainability characteristics was highest among the health and environment sectors versus the agricultural sector ($P < 0.05$). There was a relatively low level of agreement from all three sectors, particularly the environmental sector (68.7%), to consume recommended serves of dairy products. Only 38.5% of all respondents agreed with the inclusion of "organic food produce". Further, negative associations were observed between respondents' opinions regarding the sustainability of NZ's current food system and familiarity with the EAGs.

Conclusion: Professionals from the agriculture, environment and health sectors of New Zealand largely support the inclusion of sustainability characteristics within NZ's EAGs. However, a multi-sectoral approach will be required urgently during the development and implementation of sustainability guidelines to address areas of divergence.

Introduction

The global food system faces an ambitious challenge in meeting nutritional demands whilst reducing negative environmental impacts (Steffen et al., 2015b; Rockström et al., 2016; Springmann et al., 2016). Several initiatives have elaborated the concept of sustainable diets as the key for linking nutrition and sustainable food systems (Lang et al., 2009; Burlingame and Dernini, 2012; Fischer and Garnett, 2016).

Sustainable diets have been defined as those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are “protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy while optimising natural and human resources” (FAO, 2010).

The importance of sustainable diets is further reflected in the 17 UN Sustainable Development Goals (SDGs); in particular, Goal 2 (“end hunger, achieve food security and improved nutrition, and promote sustainable agriculture”) and Goal 12 (“responsible production and consumption”) (UN, 2015c).

A wealth of literature suggests that no country currently meets basic dietary needs for its citizens at a globally sustainable level of resource use (Perignon et al., 2016; Behrens et al., 2017; O’Neill et al., 2018). Human dietary patterns, both current and emerging, threaten human and environmental health (Lang et al., 2009; Burlingame and Dernini, 2012; Alsaffar, 2016; Fischer and Garnett, 2016; Candel and Pereira, 2017). The production and consumption of highly processed and animal-based foods, as well as inadequate fruit, vegetable, fibre and essential micronutrient intake, have resulted in human and planetary health degradation (HLPE, 2017).

As per other developed nations, NZ is experiencing growing rates of obesity and associated non-communicable diseases (MOH, 2011; 2015). These contribute a significant health burden on individuals, families and the nation. Further, although NZ is a small emitter in absolute terms, accounting for less than 0.2% of global emissions, its food system is a major contributor to climate change, with per-capita emissions fifth highest among Organisation for Economic Co-operation and Development (OECD) countries in 2011 (OECD, 2017b). The environmental impact of the food system is evident in NZ: damaged ecosystems, depleted fish stocks, soil degradation and loss of biodiversity, with more change expected (Metcalf et al., 2009; Hollis, 2014; Rockström et al., 2016; Apārangi, 2017).

In response, nutrition and sustainability are high priority on the global political agenda (WHO, 2017; Monteiro et al., 2018; Jones et al., 2019). Research has highlighted that, while supply-end strategies, when implemented widely, have the potential to lead to important emissions reductions (Fischer and Garnett, 2016), the potential to reduce emissions arising from within the supply chain is not nearly as significant as those that can be achieved through a demand-end approach: namely, decreasing consumption of those agricultural products that are GHG-intensive (Hollis, 2014). According to a recent report by the Food Climate Research Network, based at Oxford University, a country’s national dietary guidelines represent a key opportunity for policy development to address consumption patterns (FCRN, 2016).

A range of possible sustainable diets exist, made up of several sustainable characteristics, each of the components contributing to human and planetary health (Macdiarmid et al., 2012). Introducing these into dietary guidelines will allow governments to act on nutrition-related health objectives, while concomitantly addressing sustainability concerns (Fischer and Garnett, 2016). Internationally, governments are beginning to include sustainability characteristics into their national dietary guidelines but are moving at different rates.

The food system is complex. Several social, economic and political interactions exist between people and their food. Consequently, development and implementation of meaningful food-based dietary guidelines (FBDGs) has been associated with many challenges. The recognition of the need to integrate the full suite of impacts that dietary choices and the food system can have on the environment has exacerbated these challenges (Carey et al., 2016; DeSalvo et al., 2016; Fischer and Garnett, 2016; Jones et al., 2019; Lang, Mason., 2019; Livsmedelsverket, 2015; Ridgway et al., 2015).

Although health, environmental and humanitarian concerns are common to all sectors, differences lie in the degree to which each sector, and professionals within these sectors, perceive the importance, and viability, of methods for addressing these issues as they try to achieve their own set of interests.

The premise of a widespread dietary shift toward greater incorporation of plant-based foods and a reduction in animal-based products is viewed as “drastic and unrealistic” by many stakeholders (Sabate and Soret, 2014).

Many stakeholders have been seen to use their political influence to block or reverse policies that would make the food system more sustainable. For example, scientific committees in both the US and Australia have attempted to include environmental considerations in their respective FBDGs (Merrigan et al., 2015). However, due to a lack of government endorsement, resistance and lobbying against their implementation from a range of sectors and bodies, the most recent revisions of guidelines do not explicitly include sustainability characteristics.

In contrast, some governments have begun to incorporate a wider range of expertise and representation in their consultation and development processes of FBDGs with sustainability characteristics. For example, the 2014 Brazilian FBDGs have included representation from the education, social welfare and agriculture sectors, as well as the public (MOH, 2014). This strategy has ensured that the broader societal and environmental issues of the food system are addressed and included in the development and implementation processes. By including multiple perspectives in the development process, Brazil ensured that all recommendations were translated in a way that could be understood and followed by all stakeholders. This process has helped to mitigate resistance, lobbying and abandonment and allowed for successfully developing and implementing FBDGs with sustainability at the forefront, supported by all sectors.

As an essential and integral component of NZ’s national food policy, the inclusion of sustainability characteristics within the new dietary guidelines is plausible. However, from these examples, it is evident that systemic change is required to address the most pressing sustainability issues. Achieving this requires interdisciplinary collaboration from academia, government and industry stakeholders prior to implementation.

An opportunity to address sustainability issues exists in New Zealand’s 2015 Eating and Activity Guidelines for Adults as they do not currently include any explicit reference to sustainable dietary practices. Further, Drew et al. (2018) has conducted a contextual analysis toward developing sustainability considerations, specifically, for inclusion within NZ’s dietary guidelines. It is suggested that a diet consisting of whole plant foods, including vegetables, fruits, legumes, and whole grains, is found to be far less emissions-intensive than a diet consisting of mostly animal-based foods, particularly red and processed meats in NZ, in line with international literature.

Given that NZ’s food system is a primary driver of detrimental change to the environment and that the burden of nutrition-related chronic disease continues to grow around the world, the importance of focusing research and policy efforts on healthy and sustainable eating patterns is incontestable (Quiggin, 2010; Drew, 2018).

However, it is still unclear how such a focus would be received by key stakeholders in NZ and there is no local research specifically reporting sectoral professionals’ attitudes or opinions towards proposed, or implemented, FBDG sustainability recommendations.

Thus, the purpose of this study was to provide a quantitative account of sectoral professionals’ opinions and attitudes towards the inclusion of sustainability characteristics in NZ’s EAG series prior to implementation. Convergence of agreement between sectoral groups towards the inclusion of individual sustainability characteristics within NZ’s EAGs will be examined.

Methods

Purpose

The purpose of this study was to evaluate the divergence and convergence of agreement among sectoral groups towards the inclusion of identified sustainability characteristics within New Zealand’s Eating and Activity Guidelines for Adults (EAGs). Attitude and opinion were assessed through a series of Likert scale questions. The primary hypothesis of this study was that there are sectoral biases, and that sectoral professionals will not converge in their level of agreement about the inclusion

of sustainability characteristics with NZ EAGs. International experience suggests that sectoral professionals do not agree with the inclusion of some sustainability characteristics within food-based dietary guidelines as evidenced by lobbying and subsequent abandonment of sustainable FBDGs (Jones et al., 2019; Merrigan et al., 2015; NHMRC., 2013; Rutter et al., 2011).

Participants

Professionals from the health, environment and agriculture sectors of NZ over 18 years of age were invited to complete an online survey through contact with governing bodies, professional associations, industry associations, and advocacy groups within the health, environmental and agricultural sectors (Appendix A; Table A.2). Gender, age, education, and professional sector were determined (Table 1). Participants provided consent to the terms of the study at the initiation of the survey.

Survey Design: Attitude and Opinion

Opinions of sustainability of NZ's current food system, and the current status of NZ's EAGs, as well as attitudes towards the inclusion of individual sustainability characteristics within NZ's EAGs were measured in this survey.

Each question asked participants to state their level of agreement with a sustainability characteristic. Each sustainability characteristic was written using plain English and avoided jargon or any technical term that was outside of common usage. The opinion and attitude questions were completed using a 5-item Likert scale ranging from strongly agree, agree, don't know, disagree, to strongly disagree. The survey comprised three sections; demographic characteristics of the participants, overall sustainability and individual sustainability characteristics to discourage pattern answering (Croasmun and Ostrom, 2011).

Pre-testing the Questionnaire

To gain insight into whether survey questions were understandable, logical and understood in the manner they were intended, a pilot study was undertaken prior to the final survey being released including feedback sought from Ministry of Health key informants. The data gathered with the online pilot survey were tested to ensure appropriate data analyses were selected as well as logical progression and accessibility of the survey for the participants. For the most part, the pilot survey was deemed too long, which led to a consolidation of questions and removal of lengthy explanations of individual sustainability characteristics. For the full survey used in the research, refer to Appendix C.

Sample Size

Based on NZ Business Demography Statistics there was a 120,700 Employee Count in the Agriculture, Forestry and Fishing sector and 227,000 in the Health Care and Social Assistance sector, giving a population thought to be in excess of 300,000 (StatsNZ, 2016). Therefore, to conduct analyses of covariance with three sector groups an estimated total of 271 participants was determined. This calculation was based on a 300,000-population size with a 90% confidence interval, and a 5% margin of error (Israel., 1992; Kasunic., 2005).

Procedure

Surveys were distributed to participants via a link by email, web and social media through Survey Monkey (Survey Monkey Inc, Palo Alto, CA, USA) between June and August 2018. Emails were sent to 419 individuals across the sectors. In addition, six governing bodies either posted the survey link on their websites or included it in their monthly newsletters. The survey employed a "snowball" effect. A total of 302 responses were obtained via email (81 responses), web links (215 responses) and social media posts (6 responses).

Statistical Analysis

Collected responses were transferred to IBM SPSS 25 (2017) for analysis and edited for validation across the sectors (Health, Environment or Agriculture) using the *Australian and New Zealand Standard Industrial Classification (ANZSIC, 2006)*.

One-way ANOVA analyses were conducted to compare the level of agreement with the inclusion of sustainability statements of the sector groups: agriculture, environment and health and demographic characteristics; age and education. As described in Appendix A; Table A1, results from a one-way ANOVA show a statistically significant difference between age and education groups with level of agreement towards the inclusion of sustainability characteristic statements. Therefore, a one-way ANCOVA analysis was undertaken to detect a difference in level of agreement with the inclusion of sustainability statements of the sector groups: agriculture, environment and health whilst controlling for covariates (Table 4). Post-hoc tests were used to determine specifically where the significant differences in opinion lay between the sectors.

A correlation analysis was then conducted between individual sustainability characteristics and level of respondents' agreement with sustainability statements; The world's current food system is sustainable, New Zealand's current food system is sustainable, New Zealand needs to adopt more/better agro-ecological farming practices, I am familiar with the 2015 'Eating and Activity Guidelines for New Zealand Adults' ($r < 0.05^*$, $r < 0.01^{**}$). This was done to estimate the association between respondents' opinions regarding the sustainability statements and their level of agreement with individual sustainability characteristics (Table 5).

Following analyses, participant responses were collapsed into Disagree (D- Strongly Disagree and Disagree), Don't Know (DK) and Agree (A – Agree and Strongly Agree) for simplicity of presentation.

All data analyses were based only on non-missing data. Statistical significance was achieved if the *P*-value was < 0.05 .

Ethics

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research (see Appendix E).

Results

Following data cleaning, five respondents' surveys could not be used as they did not meet the target criteria, that is, they could not be clearly sorted into one of the specified sectors; agriculture, environment or health. The demographic characteristics of the participants are shown in Table 1. Of 298 respondents, approximately two-thirds were women. Most respondents were from the health sector (41%), a third (37%) were from the agricultural sector and 22% from the environmental sector. Most respondents (89.3%) were aged between 25 and 64 years. Within this, respondents were in the age brackets 25-34 years (28.5%), 35-44 years (23.8%), 45-54 years (19.1%) and 55-64 years (17.1%).

Most respondents (89.2%) had tertiary education and 60.7% had post-graduate education. Nearly all respondents from the health (99.2%) and environmental (94%) sectors had a tertiary education versus three-quarters of those from the agriculture sector (75.5%). There were 11% of respondents with solely a high school education.

Table 1. Demographic characteristics of respondents by sector.

	Total	Sector (%)		
		Agriculture	Environment	Health
	298 (100)	110 (37)	67 (22)	121(41)
Gender				
Men	35.2	57.3	41.4	9.9
Women	64.8	42.7	58.6	90.1
Age group (years)				
18-24	5.0	0.0	4.5	10.0
25-34	28.5	15.5	35.8	36.7
35-44	23.8	22.7	25.4	24.2
45-54	19.1	25.5	22.4	11.7
55-64	17.9	23.6	10.4	15.8
65+	5.7	12.7	1.5	1.6
Education				
Secondary	10.8	24.5	6.0	0.8
Tertiary (Under-graduate)	28.5	40.9	29.8	15.7
Tertiary (Post-graduate)	60.7	34.6	64.2	83.5

As described in Table 2, the majority of respondents (78.3%) do not believe the world's current food system is sustainable, with the lowest level of agreement by the agriculture sector (60%).

Overall, there is 77% agreement from all sectoral professionals that sustainability recommendations should be included in the eating and activity guidelines (EAGs) for adults in NZ.

Two-thirds of respondents (63.3%) believe NZ's current food system is not sustainable. Most respondents (88.6%) believe that NZ needs to adopt more/better agro-ecological farming practices.

Just under half of respondents were familiar with the 2015 *Eating and Activity Guidelines for New Zealand Adults* (46.3%).

Table 2. Respondent agreement with sustainability statements by sector

Sustainability Statement		A (%)	DK (%)	D (%)
The world's current food system is sustainable	Agriculture	27.3	12.7	60.0
	Environment	7.5	6.0	86.6
	Health	6.6	5.0	88.4
	Total	13.8	7.9	78.3
New Zealand's current food system is sustainable	Agriculture	57.4	7.4	35.2
	Environment	11.9	10.4	77.6
	Health	14.9	8.3	76.9
	Total	28	8.7	63.3
New Zealand needs to adopt more/better agro-ecological farming practices	Agriculture	80.9	5.5	13.6
	Environment	97.0	0.0	3.0
	Health	87.6	9.9	2.5
	Total	88.6	5.1	6.3
I am familiar with the 2015 "Eating and Activity Guidelines for New Zealand Adults"	Agriculture	34.5	30.9	34.5
	Environment	13.6	24.2	62.1
	Health	90.9	1.7	7.4
	Total	46.3	19	34.7
Sustainability recommendations should be included in the "Eating and Activity Guidelines for Adults"	Agriculture	57.4	7.4	35.2
	Environment	83.6	10.4	6.0
	Health	90.0	5.0	5.0
	Total %	77	7.6	15.4
Promotion of diet diversity/variety of whole foods	Agriculture	97.2	1.8	0.9
	Environment	95.5	3.0	1.5
	Health	98.3	0.8	0.8
	Total	97	1.9	1.1
Promotion of plant-based diets	Agriculture	42.7	13.6	43.6
	Environment	77.6	9.0	13.4
	Health	87.6	5.0	7.4
	Total	68.3	9.2	21.4
To limit red meat consumption as per recommendations	Agriculture	50.9	15.5	33.6
	Environment	86.4	6.1	7.6
	Health	90.0	5.8	4.2
	Total	75.8	9.1	15.1
To limit processed meat consumption as per recommendations	Agriculture	78.2	7.3	14.5
	Environment	95.5	3.0	1.5
	Health	99.2	0.8	0.0
	Total	91	3.7	5.3
To consume recommended serves of dairy products	Agriculture	73.6	11.8	14.5
	Environment	68.7	14.9	16.4
	Health	80.8	7.5	11.7
	Total	74.4	11.4	14.2
Promotion of sustainable seafood consumption	Agriculture	87.3	5.5	7.3
	Environment	91.0	7.5	1.5

Sustainability Statement		A (%)	DK (%)	D (%)
	Health	94.2	1.7	4.2
	Total	90.8	4.9	4.3
To limit/reduce ALL processed foods high in fat, salt and sugar as per recommendations	Agriculture	87.2	8.3	4.6
	Environment	88.1	7.5	4.5
	Health	96.7	1.7	1.7
	Total	90.7	5.8	3.6
To purchase and support local food produce	Agriculture	74.3	4.6	21.1
	Environment	88.1	6.0	6.0
	Health	92.6	4.1	3.3
	Total	85	4.9	10.1
To purchase and support seasonal food produce	Agriculture	86.4	2.7	10.9
	Environment	97.0	3.0	0.0
	Health	97.5	0.0	2.5
	Total	93.6	1.9	4.5
To purchase and support organic food produce	Agriculture	21.8	16.4	61.8
	Environment	59.7	14.9	25.4
	Health	33.9	24.0	42.1
	Total	38.5	18.4	43.1
Standards for the ethical treatment of livestock	Agriculture	87.3	2.7	10.0
	Environment	94.0	4.5	1.5
	Health	80.8	8.3	10.8
	Total	87.4	5.2	7.4
To reduce food waste	Agriculture	93.6	2.7	3.6
	Environment	94.0	4.5	1.5
	Health	98.3	0.8	0.8
	Total	95.3	2.7	2.0
Promotion of sustainable lifestyle behaviours (for example, physical activity)	Agriculture	96.4	3.6	0.0
	Environment	97.0	3.0	0.0
	Health	98.3	1.7	0.0
	Total	97.2	2.8	0.0
I support country of origin labelling of foods	Agriculture	89.2	2.0	8.8
	Environment	93.4	4.9	1.6
	Health	97.3	2.7	0.0
	Total	93.3	3.2	3.5
I support labelling foods with New Zealand Geographic Indicators	Agriculture	75.2	9.2	15.6
	Environment	85.1	11.9	3.0
	Health	81.0	12.4	6.6
	Total	80.4	11.1	8.4
*Introductory statement for question 7 of survey; “The following characteristics of a sustainable diet should be included and linked to both human and environmental health in the ‘Eating and Activity Guidelines for New Zealand Adults’:”				

Note. Original scale: 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Neither Agree or Disagree (N), 4 = Agree (A), 5 = Strongly Agree (A). For simplicity of presentation ‘Strongly Disagree’ and ‘Disagree’ (1+2) have been collapsed to ‘Disagree’ (D) and ‘Agree’ and ‘Strongly Agree’ (4+5) have been collapsed to Agree (A). Table 3. Respondent agreement with sustainability statements by sector (Means and SD)

Sustainability Statement	Sector	Mean (SD)	Total sample mean (SD)	P-value
The world's current food system is sustainable	Agriculture	3.47 (1.1)	3.93 (1.0)	0.00*
	Environment	4.16 (0.9)		
	Health	4.21 (0.8)		
New Zealand's current food system is sustainable	Agriculture	2.66 (1.2)	3.42 (1.2)	0.00*
	Environment	3.88 (1.0)		
	Health	3.84 (0.9)		
New Zealand needs to adopt more/better agro-ecological farming practices	Agriculture	2.15 (0.9)	1.82 (0.857)	0.003*
	Environment	1.43 (0.7)		
	Health	1.173 (0.7)		
I am familiar with the 2015 "Eating and Activity Guidelines for New Zealand Adults"	Agriculture	3.06 (1.2)	2.62 (1.358)	0.00*
	Environment	3.70 (1.1)		
	Health	1.62 (0.9)		
Sustainability recommendations should be included in the "Eating and Activity Guidelines for Adults"	Agriculture	2.68 (1.1)	2.11 (1.024)	0.00*
	Environment	1.96 (0.8)		
	Health	1.67 (0.8)		
Promotion of diet diversity/variety of whole foods	Agriculture	1.58(0.6)	1.49 (0.621)	0.627
	Environment	1.66(0.7)		
	Health	1.33(0.6)		
Promotion of plant-based diets	Agriculture	3.12 (1.3)	2.34 (1.204)	0.00*
	Environment	2.07 (1.0)		
	Health	1.77 (0.9)		
To limit red meat consumption as per recommendations	Agriculture	2.83 (1.1)	2.15 (1.085)	0.00*
	Environment	1.83 (0.9)		
	Health	1.70 (0.8)		
To limit processed meat consumption as per recommendations	Agriculture	2.14 (1.0)	1.66 (0.826)	0.00*
	Environment	1.52 (0.6)		
	Health	1.01 (0.1)		
To consume recommended serves of dairy products	Agriculture	2.32 (0.9)	2.23 (1.026)	0.272
	Environment	2.37 (1.1)		
	Health	2.06 (1.1)		
Promotion of sustainable seafood consumption	Agriculture	1.84 (0.8)	1.68 (0.806)	0.209
	Environment	1.61 (0.7)		
	Health	1.58 (0.8)		
To limit/reduce ALL processed foods high in fat, salt and sugar as per recommendations	Agriculture	1.81 (0.8)	1.62 (0.780)	0.05
	Environment	1.66 (0.9)		
	Health	1.42 (0.6)		
To purchase and support local food produce	Agriculture	2.10 (1.3)	1.79 (1.036)	0.00*
	Environment	1.75 (0.9)		
	Health	1.53 (0.8)		
To purchase and support seasonal food produce	Agriculture	1.81 (1.0)	1.54 (0.817)	0.001*
	Environment	1.51 (0.6)		
	Health	1.31 (0.6)		
To purchase and support organic food produce	Agriculture	3.55 (1.3)	3.09 (1.293)	0.00*
	Environment	2.43 (1.2)		

Sustainability Statement	Sector	Mean (SD)	Total sample mean (SD)	P-value
	Health	3.04 (1.2)		
Standards for the ethical treatment of livestock	Agriculture	1.87 (1.0)	1.80 (0.946)	0.040*
	Environment	1.55 (0.7)		
	Health	3.04 (1.2)		
To reduce food waste	Agriculture	1.53 (0.8)	1.37 (0.664)	0.188
	Environment	1.33 (0.6)		
	Health	1.24 (0.5)		
Promotion of sustainable lifestyle behaviours (for example, physical activity)	Agriculture	1.52 (0.6)	1.38 (0.539)	0.641
	Environment	1.40 (0.6)		
	Health	1.24 (0.5)		
I support country of origin labelling of foods	Agriculture	1.70 (1.0)	1.50 (0.785)	0.008*
	Environment	1.41 (0.7)		
	Health	1.37 (0.5)		
I support labelling foods with New Zealand Geographic Indicators	Agriculture	2.09 (1.093)	1.93 (0.947)	0.05
	Environment	1.70 (0.789)		
	Health	1.91 (0.856)		

Note. * Identifies level of significance $P < 0.05$. Original scale analysed: 1 = Strongly Disagree (SD), 2 = Disagree (D), 3 = Neither Agree or Disagree (N), 4 = Agree (A), 5 = Strongly Agree (A).

Table 2 and Table indicate five of the sustainability characteristics which received unanimously high levels of agreement for inclusion in New Zealand's EAGs from all three sectors (> 90%); namely, promotion of dietary diversity (97%), sustainable seafood (90.8%), to limit processed foods (90.7%), reduction of food waste (95.3%) and promotion of sustainable lifestyle behaviours (97.2%).

A significantly lower level of agreement from the agriculture sector was present for the promotion of seasonal food produce and standards for the ethical treatment of livestock; ($P < 0.05$), and for five sustainability characteristics; promotion of plants-based diets, limit red meat, limit processed meat, to purchase and support local produce and country of origin labelling of foods ($P < 0.05$).

The characteristic, "to consume recommended serves of dairy products", received a relatively low level of agreement from all three sectors, with only three-quarters of all respondents (74.4%) agreeing with the inclusion of this recommendation. The lowest level of agreement for the dairy product item was from the environmental sector (68.7%) and highest level of agreement (80.8%) from the health sector.

Further, while 80.4% of all respondents agreed with the item, "I support labelling foods with New Zealand Geographic Indicators", three-quarters (75.2%) of the agriculture sector respondents agreed.

Only 38.5% of all respondent agreed with the inclusion of the characteristic, "To purchase and support organic food produce": agriculture (21.8%), environment (59.7%) and health (33.9%). $P < 0.01$.

Table 4. Respondent agreement with sustainability statements with statistically significant difference ($P < 0.05$) by sector when gender, age and education are controlled for.

Sustainability Statement		P-value	ANCOVA covariate P-value			
			Sector	Gender	Age (years)	Education
The world's current food system is sustainable	Agriculture ^{ab}	0.00*	0.005*	0.102	0.199	0.177
	Environment ^a					

	Health ^b					
New Zealand's current food system is sustainable	Agriculture ^{ab}	0.00*	0.000*	0.706	0.994	0.616
	Environment ^a					
	Health ^b					
New Zealand needs to adopt more/better agro-ecological farming practices	Agriculture ^a	0.003*	0.007*	0.190	0.107	0.914
	Environment ^a					
	Health ^a					
I am familiar with the 2015 “Eating and Activity Guidelines for New Zealand Adults”	Agriculture ^a	0.00*	0.000*	0.224	0.127	0.022*
	Environment ^a					
	Health ^a					
Sustainability recommendations should be included in the “Eating and Activity Guidelines for Adults”	Agriculture ^{ab}	0.00*	0.000*	0.449	0.587	0.027*
	Environment ^a					
	Health ^b					
Promotion of plant-based diets	Agriculture ^{ab}	0.00*	0.000*	0.4698	0.938	0.010*
	Environment ^a					
	Health ^b					
To limit red meat consumption as per recommendations	Agriculture ^{ab}	0.00*	0.000*	0.422	0.840	0.006*
	Environment ^a					
	Health ^b					
To limit processed meat consumption as per recommendations	Agriculture ^{ab}	0.00*	0.001*	0.403	0.685	0.082
	Environment ^a					
	Health ^b					
To purchase and support local food produce	Agriculture ^{ab}	0.00*	0.000*	0.036*	0.100	0.000*
	Environment ^a					
	Health ^b					
To purchase and support seasonal food produce	Agriculture ^{ab}	0.001*	0.000*	0.063	0.022*	0.011*
	Environment ^a					
	Health ^b					
To purchase and support organic food produce	Agriculture ^{ab}	0.00*	0.000*	0.019*	0.290	0.084
	Environment ^{ab}					
	Health ^{ab}					
Standards for the ethical treatment of livestock	Agriculture	0.040*	0.017*	0.111	0.085	0.027*
	Environment ^a		0.000*	0.019*	0.290	0.084
	Health ^a					
I support country of origin labelling of foods	Agriculture ^a	0.008*	0.004*	0.235	0.565	0.006*
	Environment					
	Health ^a					
I support labelling foods with New Zealand Geographic Indicators	Agriculture	0.05	0.074	0.626	0.982	0.425*
	Environment					
	Health					

Notes. * identifies level of significance $P < 0.05$. Values with the shared superscript represent significant differences according to the Tukey HSD post-hoc test ($P < 0.05$).

A significant negative correlation exists between respondent’s agreement with the sustainability statements; “The World’s current food system is sustainable”, “NZ’s current food system is

sustainable” and “Sustainability recommendations should be included in the 'Eating and Activity Guidelines for Adults” and their agreement with the inclusion of all of the sustainability characteristics. The exception for inclusion was agreement of the characteristic “to purchase and support organic food produce”.

A significant positive relationship exists between respondent’s agreement with two of the sustainability statements and their agreement with the inclusion of all of the sustainability characteristics. Firstly, “New Zealand needs to adopt more/better agro-ecological farming practices” with exception of agreement with “to purchase and support organic food produce”. Secondly, with “I am familiar with the 2015 ‘Eating and Activity Guidelines for New Zealand Adults””, with the except for agreement with the inclusion of the sustainability characteristics “to purchase and support organic food produce” and “Standards for the ethical treatment of livestock”.

Table 5. Correlation between individual sustainability characteristics which obtained a statistically significant different level of agreement between sectors and respondents’ agreement with sustainability statements ($r < 0.05^$, $r < 0.01^{**}$).*

	Sustainability Statements				
	The World’s current food system is sustainable	NZ’s current food system is sustainable	New Zealand needs to adopt more/better agro-ecological farming practices	Sustainability recommendations should be included in the 'Eating and Activity Guidelines for Adults'	I am familiar with the 2015 “Eating and Activity Guidelines for New Zealand Adults”
<i>Characteristic</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>	<i>R</i>
Promotion of plant-based diets	-0.377**	-0.393**	0.952**	-0.245**	0.205**
To limit red meat consumption as per recommendations	-0.492**	-0.399**	0.980**	-0.377**	0.156**
To limit processed meat consumption as per recommendations	-0.645**	-0.298**	0.959**	-0.301**	0.130*
To purchase and support local food produce	-0.637**	-0.248**	0.921**	-0.298**	0.070
To purchase and support seasonal food produce	-0.650**	-0.232**	0.866**	-0.262**	0.053
To purchase and support organic food produce	0.649**	-0.279**	-0.208**	-0.574**	-0.098
Standards for the ethical treatment of livestock	-0.631**	-0.106	0.983**	-0.308**	-0.168**

I support country of origin labelling of foods	-0.675**	-0.193**	0.836**	-0.255**	0.085
*Introductory statement for question 7 of survey; “The following characteristics of a sustainable diet should be included and linked to both human and environmental health in the ‘Eating and Activity Guidelines for New Zealand Adults’:”					

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Discussion

This study is the first to assess the degree of convergence between sectoral groups for the inclusion of sustainability characteristics into New Zealand’s (NZ) eating and activity guidelines (EAGs).

Overall, findings demonstrate strong support across NZ sectoral professionals, with 77% indicating agreement that sustainability recommendations should be included in the revised *Eating and Activity Guidelines for New Zealand Adults*.

This high level of support highlights the degree to which sectors view the importance of sustainable food systems as an important issue in NZ. The support demonstrated in this study, in line with international findings, suggests dietary guidelines are an appropriate medium for introducing sustainable eating patterns into nutrition policy and creating consumer awareness (Burlingame and Dernini, 2012; Bechthold et al., 2018; Oshiro et al., 2018; Ritchie et al., 2018; Jones, 2019).

Similar multi-sectoral support has been demonstrated in Australia (Ridgway et al., 2015). Sectoral professionals have been responsive to the concept of combining health and sustainability, many already utilising it within their organisations. For example, as evidenced by the launch of *One Blue Dot: Environmentally Sustainable Diet Toolkit*, the British Dietetics Association (BDA)’s Environmentally Sustainable Diet Project for dietitians, (BDA, 2018; James et al., 2018).

While this study’s findings suggest the existence of overall support, the level of agreement varies by sector. Health professionals support the inclusion of sustainability recommendations within the EAGs the most (90%), followed by respondents from the environment (83.6%) and agriculture (57.4%) sectors.

Disunity between sectors has also been demonstrated in America, Australia and Sweden (Carey et al., 2016; DeSalvo et al., 2016; Fischer and Garnett, 2016; Land, Mason., 2019; Livsmedelsverket, 2015; Ridgway et al., 2015;). These countries found that, due to variations in the individual sector’s interests in the food system, high levels of overall support during development was later met with fierce opposition and subsequent abandonment of sustainability characteristics within FBDGs (Ridgway et al., 2015; Fischer and Garnett, 2016). The divergence of opinion in the current study’s findings therefore suggests a similar conflict may surround adoption of sustainable dietary guidelines in NZ.

In America, dietary guidelines are jointly developed and issued by the US Department of Health and Human Services as well as the US Department of Agriculture. In this case, the opposing opinions and subsequent lobbying of the agricultural sector carried enough influence during implementation to override the supporting views of health sector professionals. The administration structure, combined with economic influence, may explain the ongoing absence of sustainability characteristics in America. In contrast, successful development and implementation of national dietary guidelines with integrated sustainability principles in Qatar is thought to be primarily due to a lack of industry influence (Seed, 2015).

These examples, and the significantly lower level of support from the agriculture sector in the current study, posits the question whether primary industry should be part of the development of FBDGs. Suggestions have been made that this industry should be omitted from dietary guideline development

discussions and setting of the policy agenda, and only be involved in the implementation of actions (He et al., 2014; Jones et al., 2016).

However, like NZ, Australian FBDG development is led solely by the health sector. Despite this administration structure, the widespread support for the integration of environmental considerations into guidelines was largely ignored in the latest revision (Ridgway et al., 2015). Again, the food and agriculture organisations and industry lobbyists in Australia were given disproportionate influence over the way that the National Food Plan was shaped (Carey et al., 2016).

The significantly lower level of support from the agriculture sector in this study highlights the need to mitigate the risk of sectoral lobbying in NZ via wider, earlier and higher levels of engagement with relevant sectors and individuals to increase overall multi-sectoral agreement, prior to implementation (EFSA, 2010; Bowen et al., 2014). Instead of excluding the primary industry from FBDG development and implementation, a number of changes, namely, to enhance transparency, manage biases and conflicts of interest, may be required (NAoS, 2017). By adopting this approach, FBDGs have been successfully developed and implemented in several countries including Brazil, Germany, Sweden, Netherlands and Qatar, as well as into “quasi-official” guidelines in France and Estonia. Similar to NZ, guideline development is led by the health sector, but is elaborated in a participatory manner, in consultation with multiple sectors of the society, including agriculture and environment sectors (HCofN, 2011; GCSD, 2013; Fischer and Garnett, 2016; Jones et al., 2019).

These examples suggest that the development of NZ guidelines can remain with the health sector but, as the agriculture sector’s support for change is imperative, should be supported and guided by input from the agriculture and other relevant sectors (Ridgway et al., 2015; James et al., 2018).

In order to understand the opinions and attitudes NZ sectoral professionals hold towards sustainable dietary guidelines, and to further explain the divergence of opinion between the sectoral groups, this study assessed each sector’s level of agreement towards individual sustainability characteristics. It found an overall, unanimous, high level of agreement from professionals from the agriculture, environment and health sectors with the inclusion of five of the fifteen sustainability characteristics into the EAGs: promotion of dietary diversity (97%), sustainable seafood (90.8%), to limit processed foods (90.7%), reduction of food waste (95.3%) and promotion of sustainable lifestyle behaviours (97.2%) ($P > 0.05$). Further, although a statistically significant difference of level of agreement was found between sectors ($P < 0.05$) for the inclusion of promotion of seasonal food produce (93.6%) and standards for the ethical treatment of livestock (87.4%) overall, a relatively high level of agreement from all sectors was shown. It is important to distinguish between convergence of opinion with an overall high level (%) of agreement, convergence of opinion with an overall low level of agreement and divergence with overall high level of agreement, when assessing whether opposition towards a sustainability characteristic is likely.

An overall high level of agreement, with or without convergence, suggests that the inclusion of these sustainability characteristics is likely to receive support if implemented into NZ’s EAGs. Worldwide, partial implementation of sustainability characteristics within FBDGs exists, tailored to the needs and challenges of each country, as described in Figure 2 (Jones et al., 2019). The results of the current study suggest that the sole inclusion of these seven characteristics may, at this time, act as a starting point for NZ towards implementing all sustainable dietary guidelines and should be included in the next revision of the EAGs currently taking place.

In contrast, divergence of opinion between sector groups, with a relatively lower level of agreement from one or more sectors, was associated with five of the fifteen proposed sustainability characteristics. Agreement with the promotion of plants-based diets, limit red meat, limit processed meat, to purchase and support local produce and inclusion of country of origin labelling of foods were all supported significantly less by the agriculture sector respondents, compared to the health and environment sector respondents ($P < 0.05$). Further, the item “to consume recommended serves of dairy products”, received a relatively low level of agreement from all three sectors with only three-quarters of all respondents (74.4%) agreeing with the inclusion of this item.

This divergence of opinion, as well as low level of agreement from specific sectoral groups towards these individual characteristics, may exist primarily due to vested interests associated with each of the sectors. It has been well documented that vested interests, and conflict of interest, drive attitudes and subsequent behaviours (Chaiken and Baldwin, 1981; Wheeler, 2008; Hoek et al., 2017). Interests of sectoral groups, if in conflict with the proposed sustainability recommendations, may drive attitudes opposing the inclusion of sustainability characteristics into FBDGs. This may explain the abandonment of sustainability considerations in Australia's 2013 guideline revision, delayed implementation in Sweden and may be a barrier to the inclusion of sustainability characteristics in NZ's next EAG revision.

For example, both the health and environment sectors may be significantly more in favour of the inclusion of sustainability characteristics due to the close alignment of the characteristics with their goals. That is, that those diets that are good for human health are also healthy for the environment (Pimentel and Pimentel, 2003; Estruch et al., 2013; Clark and Tilman, 2017; Wolk, 2017)

In contrast, dairy products have been shown to have significant negative environmental impacts. This may explain the significantly lower level of agreement from the environmental sector respondents (68.7%), suggesting they would prefer dairy consumption lower than the current guidelines. However, some dairy components, such as calcium, bioactive proteins, milk fatty acids, and the whole dairy food matrix, are considered indispensable sources of nutrition by the health sector. This may explain the health sector respondents' support of promoting dairy consumption to meet current health guidelines (80.8%), and their disagreement with reducing it further (Louie and Rangan, 2018).

Many of the proposed sustainability characteristics for inclusion into NZ's EAGs may directly conflict with agricultural interests. Beef and lamb production are a key component of the NZ agriculture system but conflict with several proposed characteristics, such as reducing global livestock production, and the associated consumption of meat and dairy, which other sectors see as key to mitigating climate change. For example, plant-based diets require significantly fewer agricultural inputs, such as energy, petroleum, fertilisers, pesticides, herbicides and water, and emit far fewer greenhouse gas emissions than do meat-heavy diets (Tilman and Clark, 2014; Melina et al., 2016). Further, while the focus on local and seasonal foods is shown to improve farmer-consumer relationships, increase revenue for small farmers, and encourage consumption of a wider diversity of foods, this is also a direct threat to the large volumes of food produced, processed and transported by the food industry (Brown and Miller, 2008). Both have the potential to negatively impact specific aspects of their industry and thus, the attitudes and behaviours of those involved (Sivacek and Crano, 1982).

The removal of the sustainability characteristics, "Promotion of plant-based diets" and "To limit red meat consumption as per recommendations", due to divergence of opinion and low levels of overall agreement, should not be considered from an environmental perspective. This is due to the disproportionate impact that agriculture sector emissions have been shown to have on the sustainability of NZ's food and health environment (Clark and Tilman, 2017).

This divergence simply highlights the urgency for NZ to address these areas and further emphasises why any disproportionate influence the agriculture sector has in policy development may prevent NZ reaching its 2030 emission targets.

The results suggest that, in line with Brazil's development and implementation strategy, a multi-sectoral approach may be required during the development and implementation of sustainability guidelines in NZ.

Only one characteristic, the recommendation "to purchase and support organic food produce", received a low level of support for its inclusion in the EAGs from all three sectors; agriculture (21.8%), environment (59.7%) and health (33.9%). The low levels of agreement suggest that implementation of this characteristic may be receive opposition in NZ. However, unlike "red meat" and "plant-based", more knowledge and awareness of impacts is required before successful

inclusion. For example, recent international analyses examining the comparative impacts of organic and conventional systems have, of necessity, been limited to a few environmental indicators or in statistical strength of their inferences because of small sample size (Mondelaers et al., 2009; Seufert et al., 2012). Also, in NZ, exposure to agricultural chemicals and contaminants from food remains low (MPI, 2018). Therefore, the inclusion of this statement is less critical compared to “red meat” and “plant-based” recommendations.

Lastly, this study found that 28% of respondents believe that NZ’s current food system is sustainable. This varied by sector; over half (57%) of the agriculture sector respondents agreed with the statement that NZ’s food system is sustainable, compared to less than 15% of respondents from the health and environmental sectors ($P < 0.05$). Further, agreement with this statement correlates with disagreement with the inclusion of seven of the individual sustainability characteristics. This opinion, held predominantly by the agriculture sector respondents, may explain the divergence of level of agreement from the agriculture sector towards these individual sustainability characteristics.

It further highlights the persistence of the academic landscape of sustainability, science and education to consist of rather separate clusters of individual disciplines. Research regarding the current, largely unsustainable state of NZ’s food system may not have been communicated in a way in which all stakeholders can recognise and relate to their sector. There has been an historic battle of understanding and defining the term “sustainability” across professions (Costanza and Patten, 1995; Toman, 1995; Mebratu, 1998; Vos, 2007). Therefore, an opportunity for multi-disciplinary education may be a tool to bridge the gap between sectoral opinions and subsequent agreement with sustainability guidelines (Kajikawa et al., 2007). For example, in Sweden, although initially critical, the dairy organisations eventually expressed their support for the incorporation of environmental sustainability in the Swedish FBDGs once they became more informed, leading to their engagement in the development of the guidelines.

A statistically significant positive correlation was observed between respondents’ familiarity with the 2015 *Eating and Activity Guidelines for New Zealand Adults* and the individual sustainability characteristics. Similarly, a significant difference was found between the sector groups with 14% agriculture, 35% environment and 91% health sector respondents being familiar with the guidelines. It is understandable that professionals in the environment and agriculture sectors are less familiar with the guidelines, compared to the health sector, as they are not frequently required in their work. However, it highlights that awareness and knowledge of the guidelines impacts agreement with inclusion of sustainability characteristics within the guidelines. This further highlights a need for dialogue among stakeholders from across the different sectors for successful FBDG development frameworks to exist and suggests where informative techniques may be useful (James et al., 2018).

A negative correlation was observed between respondents’ agreement that “The World’s current food system is sustainable” and “NZ’s current food system is sustainable” with the agreement towards the inclusion of individual sustainability characteristics. This suggests that, the more unsustainable an individual believes a system is, the more likely they are to support the inclusion of sustainability characteristics into FBDGs. As suggested by the planned-behaviour theoretical framework, this may suggest an area where informational strategies can be aimed to inform attitudes and subsequent opinions (Ajzen., 1985, 1991). Informational strategies may be aimed to increase sectoral professionals’ knowledge of the unsustainable nature of the World’s and New Zealand’s food systems to heighten their awareness and increase agreement with policy change.

A positive correlation was observed between respondents’ agreement with “New Zealand needs to adopt more/better agro-ecological farming practices” and seven of the individual sustainability characteristics, excluding “To purchase and support organic food produce” ($P < 0.01$).

In contrast, a negative correlation was observed between respondents’ agreement with “Sustainability recommendations should be included in the 'Eating and Activity Guidelines for Adults’” and all eight of the sustainability characteristics. This suggests discrepancy between the guidelines as a whole and

the individual characteristics of a sustainable diet. This highlights the need for characteristics to be treated individually, with input gathered from, and education provided to, all stakeholders.

Strengths and limitations

A strength of this study is that it provides a snapshot of how the inclusion of sustainability characteristics within dietary guidelines may be received in NZ at this time. Despite a myriad of evidence calling for multi-sectoral approaches to guideline development, this study has provided the first detailed examination of the degree of convergence between professional sectoral groups, both internationally and in NZ, for the inclusion of sustainability characteristics into dietary guidelines. There are limitations to this study. Self-reported responses to the attitudinal questions may be influenced by social desirability, a sense of social responsibility as a result of increasing global awareness of sustainability and its importance (Vermeir and Verbeke, 2006). Respondents may have answered the questions in a way they believe they should or wish to be perceived as a result of their knowledge on the subject, either intentionally or unintentionally (Cadmus-Bertram and Patterson, 2013). However, the results of this study, including several areas with little or no convergence of opinion, suggest this did not impact all responses.

Conclusion

This study aimed to evaluate attitudes towards inclusion of sustainability characteristics within New Zealand's eating and activity guidelines (EAGs) by professionals in the agriculture, environment and health sectors. An online survey to ascertain the level of agreement sectoral professionals hold towards the inclusion of sustainability characteristics within NZ's EAGs was developed and the findings suggest that there is strong support, with 77% indicating agreement that sustainability recommendations should be included in EAGs. However, while overall support exists, when controlling for other variables, level of agreement varies by sector, with health and environmental professionals supporting the inclusion more than do the agriculture sector respondents. Individual sustainability characteristics show a unanimous, high level of agreement from all professionals with the inclusion of five of the fifteen sustainability characteristics: dietary diversity, sustainable seafood, to limit processed foods, reduced food waste and sustainable lifestyle behaviours. In contrast, agreement with promotion of plants-based diets, limits on red and processed meats, to purchase and support local produce and inclusion of country of origin labelling of foods were all supported significantly less by the agriculture sector respondents, compared to the health and environment sector respondents. Further, the item "to consume recommended serves of dairy products", received a relatively low level of agreement from all three sectors (74.4%). Only one characteristic, the recommendation "to purchase and support organic food produce" received a low level of support from all three sectors. Lastly, a significant negative correlation was observed between respondents' familiarity with the 2015 EAGs and four of the individual sustainability characteristics, and between respondents' agreement that "NZ's current food system is sustainable" and seven individual characteristics. It is imperative to evaluate the convergence of agreement between sectoral groups in NZ in order to determine whether there is opposition or support towards the inclusion of sustainability characteristics. This may inform the development and implementation of effective dietary guidelines and aid in a shift towards a sustainable food system (Hamm, 2008; Fischer and Garnett, 2016).

Contribution to research

The high level of support for sustainability integration into the EAGs found in this study highlights the degree to which sectors view the importance of sustainable food systems in NZ. This research also highlights that, as demonstrated in America, Australia and Sweden, NZ is at risk of disunity between sectors, leading to opposition and subsequent abandonment of sustainability characteristics within EAGs following implementation. It appreciates that, although there is currently an apparent disconnect between the health, agricultural and environmental sector respondents' opinions and attitudes, there are also undeniable links which present unexplored opportunities for cooperative problem solving. NZ is in a unique position for, prior to implementation, multi-sectoral participatory dialogue to identify and clarify the specific shape that sustainability should take in FBDGs. The

significantly lower level of support from the agriculture sector respondents in this study highlights the need to mitigate the risk of predominantly agriculture sectoral lobbying in NZ via wider, earlier and higher level of engagement with relevant sectors and individuals to increase overall multi-sectoral agreement (EFSA, 2010; Bowen et al., 2014). Instead of excluding the primary industries from FBDG development and implementation, several changes, namely, to enhance transparency and to manage biases and conflicts of interest, may be adopted prior to implementation (NAoS, 2017). Overall, this research has brought a diverse range of academic and professional expertise that spans the agriculture, environment and health sectors and evaluated convergences and divergences of opinions. The findings of this study should be of interest to government sectors that can influence sustainability and health, for example, departments or ministries of health, education, primary industries, regional development, agriculture, food and finance.

Chapter 4: CONCLUSION

Most national dietary guidelines are remiss in that they do not address the IPCC goals of keeping global temperatures from rising more than 2 degrees Celsius above preindustrial levels unless other sectors almost fully decarbonise by 2050 (Ritchie et al., 2018). To meet obligations, research suggests that food-based dietary guidelines (FBDGs) must integrate sustainability characteristics in a manner which is appropriate and meaningful to each country. This study is in line with literature which suggests that, for long-term, meaningful integration, sustainability characteristics should be developed into FBDGs using a multi-disciplinary approach (Jones et al., 2019). Early involvement of stakeholders is recommended to promote the acceptance of the outcome. Only in this manner will FBDGs be consistent with other public policies that have an impact on food availability and could be integrated with other policies related to health promotion.

This study aimed to evaluate attitudes towards inclusion of sustainability characteristics within New Zealand's eating and activity guidelines (EAGs) by professionals in the agriculture, environment and health sectors. An online survey to ascertain the level of agreement the NZ sectoral professionals hold towards the inclusion of sustainability characteristics within NZ's EAGs was developed and the findings suggest that there is strong support across sectoral professionals, with 77% indicating agreement that sustainability recommendations should be included in EAGs. However, while overall support exists, when controlling for other variables, level of agreement varies by sector. Health and environmental professionals support the inclusion more than the agriculture sector respondents. When individual sustainability characteristics were examined, a unanimous, high level of agreement from all professionals was found for the inclusion of five of the fifteen sustainability characteristics: dietary diversity, sustainable seafood, to limit processed foods, reduced food waste and sustainable lifestyle behaviours. In contrast, agreement with promotion of plants-based diets, limits on red meat and processed meat, promotion to purchase and support local produce and inclusion of country of origin labelling of foods were all supported significantly less by the agriculture sector respondents, compared to those from the health and environment sectors. Further, the recommendation "to consume recommended serves of dairy products", received a relatively low level of agreement from all three sectors, with only three-quarters of all respondents (74.4%) agreeing with its inclusion. Only one characteristic, the recommendation "to purchase and support organic food produce", received a low level of support from all three sectors.

This study suggests that, the more unsustainable an individual believes the World and New Zealand's food system is, the more likely they are to support the inclusion of sustainability characteristics into FBDGs. This suggests where informational strategies regarding the unsustainable state of the food system may be appropriate in obtaining consensus for policy change, including sustainable FBDGs. Further, the positive correlation observed between respondents' agreement with "New Zealand needs to adopt more/better agro-ecological farming practices" and the negative correlation between respondents' agreement with "Sustainability recommendations should be included in the 'Eating and Activity Guidelines for Adults'" and eight of the sustainability characteristics suggest discrepancy between the guidelines as a whole and the individual characteristics of a sustainable diet. This highlights the need for characteristics to be treated individually, with input gathered from, and education provided to, all stakeholders. It is therefore imperative to evaluate the convergence of agreement between sectoral groups in order to inform the development and implementation of effective dietary guidelines which are supported by all stakeholders of the food system and shift NZ towards a sustainable food future (Fischer et al, 2016; Hamm, 2008).

Contribution to research

The high level of support for sustainability integration into the EAGs found in this study highlights the degree to which sectors view the importance of sustainable food systems in New Zealand. This research also highlights that, as demonstrated in America, Australia and Sweden, New Zealand is at risk of disunity between sectors leading to opposition and subsequent abandonment of sustainability characteristics within EAGs following implementation. It appreciates that, although there is currently an apparent disconnect between the health, agricultural and environmental sector respondents' opinions and attitudes, there are also undeniable links which present unexplored opportunities for

cooperative problem solving. New Zealand is in a unique position for, prior to implementation, multi-sectoral participatory dialogue to identify and clarify the specific shape that sustainability should take in FBDGs. The significantly lower level of support from the agriculture sector respondents in this study highlights the need to mitigate the risk of predominantly agriculture sectoral lobbying in NZ, via wider, earlier and higher level of engagement with relevant sectors and individuals to increase overall multi-sectoral agreement (EFSA, 2010; Bowen et al., 2014). Instead of excluding the primary industries from FBDG development and implementation, several changes, namely, to enhance transparency and to manage biases and conflicts of interest, may be adopted prior to implementation (NAoS, 2017). Overall, this research has brought a diverse range of academic and professional expertise that spans agriculture, environment and health sectors and evaluated convergences and divergences of these opinions. The findings of this study should be of interest to Government sectors with an interest in and who can influence sustainability and health, for example, departments or ministries of health, education, primary industries, regional development, agriculture, food and finance.

Strengths

A strength of this study is that it provides a snapshot of how the inclusion of sustainability characteristics within dietary guidelines may be received in New Zealand at this time. This contributes to the limited body of research surrounding the perception of stakeholders surrounding sustainable dietary guidelines. Despite a myriad of evidence calling for a multi-sectoral approach to guideline development, this study has provided the first detailed examination of the degree of convergence between professional sectoral groups, both internationally and in New Zealand, for the inclusion of sustainability characteristics into dietary guidelines. This study also highlights potential barriers for successful development in New Zealand and highlights how these may be mitigated in line with international literature. Another major strength of this research is the large sample size and the inclusion of a representative distribution of sectoral professionals from the agriculture, environment and health sectors of New Zealand.

Limitations

There are limitations to this study. A challenge of any survey research is finding and recruiting participants from the target population. This challenge is compounded by an online survey with its distribution limitations. As a result of the online format, I was unable to randomise my sample population, which may have resulted in reduced variation in data. Instead, I resorted to self-directed sampling, which means that I solicited participants and groups of respondents to ensure a diverse mix.

Self-reported responses to the attitudinal questions may be influenced by social desirability, a sense of social responsibility as a result of increasing global awareness of sustainability and its importance (Vermeir and Verbeke, 2006). Respondents may have answered the questions in a way they believed they should (as a result of their knowledge), either intentionally or unintentionally (Cadmus-Bertram and Patterson, 2013). However, the results of this study, including several areas with little or no convergence of opinion, suggest this did not impact several responses.

Another limitation is the potential for differing interpretations of the term “sustainability characteristics” for inclusion in EAGs. However, the term was explained further when individual sustainability characteristics were asked about.

This study is also limited by the study population, which does not statistically examine sub-sectors of the agriculture, environment and health sectors of New Zealand. It is recommended that this type of analysis be made in future surveys.

Final Recommendations

Recommendations for EAG Development and Implementation

This study has highlighted that dietary guidelines are an appropriate medium for introducing sustainable eating patterns into nutrition policy and creating consumer awareness.

1. Development of New Zealand food-based dietary guidelines should remain with the health sector but, as the agriculture sector's support for change is imperative, should be supported and guided by input from the agriculture and other relevant sectors.

Partial implementation of individual sustainability characteristics may be appropriate in New Zealand at this time, as follows:

2. Those characteristics which obtained unanimous, high level of agreement from all professionals or, overall, a relatively high level of agreement from all sector respondents, may be included in the next revision of *Eating and Activity Guidelines for New Zealand Adults* as these are likely to receive support if implemented; namely, promotion of dietary diversity, sustainable seafood, to limit processed foods, reduction of food waste, promotion of sustainable lifestyle behaviours, promotion of seasonal food produce and standards for the ethical treatment of livestock.
3. Those characteristics which obtained divergence of opinion, as well as low level of agreement from specific sectoral groups or received a relatively low level of agreement from all three sectors require wider, earlier and higher levels of engagement with relevant sectors and individuals to increase overall multi-sectoral agreement prior to implementation to mitigate the risk of sectoral lobbying in NZ; namely, plants-based diets, limit red meat and processed meat, to purchase and support local produce, inclusion of country of origin labelling of foods and to consume recommended serves of dairy products. These characteristics should not be excluded due to risk of opposition as they are imperative to reducing the NZ's food system's adverse impact on human and planetary health.
4. The recommendation to purchase and support organic food produce received low levels of agreement from respondents from all three sectors. However, at this time, in NZ, exposure to agricultural chemicals and contaminants from food remains low (MPI, 2018). This suggests that implementation of this characteristic would be highly problematic in NZ and should not be included at this time.
5. Lastly, an opportunity for multi-disciplinary education may be a tool to bridge the gap between sector opinions and subsequent agreement with sustainability guidelines, specifically, regarding sustainability of the World's and NZ's food system and familiarity with NZ EAGs.

Recommendations for Future Research

This project has highlighted several gaps in existing research and has identified opportunities for further exploration. Overall, further understanding of diverging opinions and a strategy to increase level of agreement is needed:

1. Further research should focus on, and explore further, the opinions of professionals from the agriculture sector.

2. Sub-sector examination should also be conducted for all professional sectors to provide a more robust representation of all stakeholders and allow specific areas in which barriers and opportunities exist.
3. Future research should investigate other methods of assessing attitudes and opinions in sectoral professionals; that is, quantitative and qualitative research to allow for more detailed examination and feedback. Specifically, given the low level of agreement from the agriculture sector respondents, future research should focus on what drives these opinions.
4. Finally, the scope of this project was limited to looking at the professionals from the health, environment and agriculture sectors. However, as a concept, sustainable diets encompass much more, including public and food industry attitudes and opinions. Therefore, this research should be integrated with analysis of these factors.
5. Once established, FBDGs should be implemented and their impact monitored and evaluated. Therefore, research is needed around how this can be achieved using a multi-sectoral approach. Such information is likely to provide additional leverage for instituting policy change at the local council or governmental level.

In summary, the findings of this research suggest a way forward to achieve a sustainable NZ food future through key stakeholder collaboration in the development and implementation of future EAGs. I hope that this research has acted as a first step towards sustainability inclusion into New Zealand's EAGS and created a platform on which further dialogue and action can develop.

References

- Albarracín, D., McNatt, P. S., Klein, C. T., Ho, R. M., Mitchell, A. L., Kumkale, G. T. (2003). Persuasive communications to change actions: an analysis of behavioral and cognitive impact in HIV prevention. *Health psychology*, 22(2), 166.
- Alsaffar, A.A. (2016). Sustainable diets: The interaction between food industry, nutrition, health and the environment. *Revista de Agaroquímica y Tecnología de Alimentos* 22(2), 102-111.
- Apārangi, R.S.T. (2017). "Human Health Impacts of Climate Change for New Zealand: Evidence Summary". (Wellington, NZ: The Royal Society Te Apārangi, 2017).
- Ajzen, I. (1991). The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.
- BDA (2018). *One Blue Dot: Environmentally Sustainable Diet Toolkit* [Online]. British Dietetic Association, UK. Available: https://www.bda.uk.com/professional/resources/environmentally_sustainable_diet_toolkit_-_one_blue_dot [Accessed 8 Dec 2018].
- Beauman, C., Cannon, G., Elmadfa, I., Glasauer, P., Hoffmann, I., Keller, M., et al. (2005). The principles, definition and dimensions of the new nutrition science. *Public Health Nutrition* 8(6a), 695-698.
- Bechthold, A., Boeing, H., Tetens, I., Schwingshackl, L., and Nöthlings, U. (2018). Perspective: Food-Based Dietary Guidelines in Europe—Scientific Concepts, Current Status, and Perspectives. *Advances in Nutrition* 9(5), 544-560.
- Behrens, P., Kieft-de Jong, J.C., Bosker, T., Rodrigues, J.F.D., de Koning, A., and Tukker, A. (2017). Evaluating the environmental impacts of dietary recommendations. *Proceedings of the National Academy of Sciences*. doi: 10.1073/pnas.1711889114.
- Bennett, H., Jones, R., Keating, G., Woodward, A., Hales, S., and Metcalfe, S. (2014). Health and equity impacts of climate change in Aotearoa-New Zealand, and health gains from climate action. *Migration* 3, 12-16.
- Bharucha, Z., and Pretty, J. (2010). The roles and values of wild foods in agricultural systems. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 365(1554), 2913-2926.
- Blanchard, J.L., Watson, R.A., Fulton, E.A., Cottrell, R.S., Nash, K.L., Bryndum-Buchholz, A., et al. (2017). Linked sustainability challenges and trade-offs among fisheries, aquaculture and agriculture. *Nature Ecology & Evolution* 1(9), 1240-1249. doi: 10.1038/s41559-017-0258-8.
- Bowen, K.J., Ebi, K., and Friel, S. (2014). Climate change adaptation and mitigation: next steps for cross-sectoral action to protect global health. *Mitigation and adaptation strategies for global change* 19(7), 1033-1040.
- Brown, C., and Miller, S. (2008). The impacts of local markets: a review of research on farmers markets and community supported agriculture (CSA). *American Journal of Agricultural Economics* 90(5), 1298-1302.
- Brundtland, G.H. (1987). "Our Common Future (Brundtland Report)", in: *Comissão Mundial*. (Oxford: World Commission on Environment and Development).
- Burlingame, B. (2014). Grand challenges in nutrition and environmental sustainability. Specially Grand Challenges. *Frontiers in Nutrition*. Doi: 10.3389/fnut.2014.00003.
- Burlingame, B. (2019). "Towards a Code of Conduct for Sustainable Diets" in *Sustainable Diets: Linking Nutrition and Food Systems* ed. B. B, S, Dernini. (CAB International), 268.
- Burlingame, B., and Dernini, S. (2011). Sustainable diets: the Mediterranean diet as an example. *Public health nutrition* 14(12A), 2285.
- Burlingame, B., and Dernini, S. (2012). *Sustainable Diets and Biodiversity: Directions and Solutions for Policy, Research and Action. International Scientific Symposium, Biodiversity and Sustainable Diets United Against Hunger, FAO Headquarters, Rome, Italy, 3-5 November 2010*. Rome: Food and Agriculture Organization of the United Nations (FAO).
- Cadmus-Bertram, L., and Patterson, R.E. (2013). "Overview of nutritional epidemiology," in *Nutrition in the Prevention and Treatment of Disease (Third Edition)*. (Elsevier), 107-124.
- Candel, J.J.L., and Pereira, L. (2017). Towards integrated food policy: Main challenges and steps ahead. *Environmental Science and Policy* 73, 89-92. doi: 10.1016/j.envsci.2017.04.010.

- Carey, R., Caraher, M., Lawrence, M., and Friel, S. (2016). Opportunities and challenges in developing a whole-of-government national food and nutrition policy: lessons from Australia's National Food Plan. *Public health nutrition* 19(1), 3-14.
- CBD (2006). *COP 8 Decision VIII/23 Agricultural biodiversity. Cross-cutting initiative on biodiversity for food and nutrition. Convention on Biological Diversity*. [Online]. Available: <https://www.cbd.int/decision/> [Accessed 12 Feb 2018].
- Chaiken, S., and Baldwin, M.W. (1981). Affective-cognitive consistency and the effect of salient behavioral information on the self-perception of attitudes. *Journal of Personality and Social Psychology* 41(1), 1.
- Clark, M., and Tilman, D. (2017). Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice. *Environmental Research Letters* 12(6), 064016.
- Costanza, R., and Patten, B.C. (1995). Defining and predicting sustainability. *Ecological economics* 15(3), 193-196.
- Croasmun, J.T., and Ostrom, L. (2011). Using Likert-Type Scales in the Social Sciences. *Journal of Adult Education* 40(1), 19-22.
- Dahlbacka, B. and Spencer, P. (2010). Sweden Withdraws Proposal on Climate Friendly Food Choices. December 2, 2010. GAIN Report SW1007. USDA Foreign Agricultural Service Global Agricultural Information, Stockholm, Sweden.
- de Coninck, H., Revi, A (2018). *Chapter 4: Strengthening and implementing the global response Coordinating Lead Authors: (India). Global Warming of 1.5oC. An IPCC special report on the impacts of global warming of 1.5oC above pre-industrial levels and related GHGe, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. [Online]. <http://www.ipcc.ch/report/sr15/>. [Accessed 10 Oct 2018].
- De Fraiture, C., Molden, D., and Wichelns, D. (2010). Investing in water for food, ecosystems, and livelihoods: An overview of the comprehensive assessment of water management in agriculture. *Agricultural Water Management* 97(4), 495-501.
- DESA (2015). "World Population Prospects: The 2015 revision, key findings and advance tables". (United Nations Department of Economic and Social Affairs, Population Division: Working Paper No. ESA/P/WP. 241).
- DeSalvo, K.B., Olson, R., and Casavale, K.O. (2016). Dietary guidelines for Americans. *Jama* 315(5), 457-458.
- Donini, L. M., Dernini, S., Lairon, D., Serra-Majem, L., Amiot, M. J., Del Balzo, V., & Polito, A. (2016). A consensus proposal for nutritional indicators to assess the sustainability of a healthy diet: the Mediterranean diet as a case study. *Frontiers in nutrition*, 3, 37.
- Drew, J.M. (2018). *Healthy & Climate-friendly Eating Patterns for New Zealand* (Thesis, Bachelor of Medical Science with Honours). University of Otago. Retrieved from <http://hdl.handle.net/10523/8058>.
- EFSA (2010). Scientific opinion on establishing food-based dietary guidelines. *EFSA Journal* 8(3), 1460.
- Estruch, R., Ros, E., Salas-Salvadó, J., Covas, M.-I., Corella, D., Arós, F., et al. (2013). Primary prevention of cardiovascular disease with a Mediterranean diet. *New England Journal of Medicine* 368(14), 1279-1290.
- FAO (1998). "Preparation and use of food-based dietary guidelines". (Rome, Italy: Food and Agriculture Organization of the United Nations).
- FAO (2010). "Final Document of the International Scientific Symposium: Biodiversity and Sustainable Diets United Against Hunger". (Rome, Italy: FAO Headquarters).
- FAO (2016). "UN General Assembly proclaims Decade of Action on Nutrition". (Rome, Italy: Food and Agriculture Organization of the United Nations).
- FCRN (2016). "Metrics for sustainable healthy diets: why, what, how?: A report of a meeting, and ideas about next steps". (Oxford, UK: Environmental Change Institute at the University of Oxford).

- Fischer, C.G., and Garnett, T. (2016). *Plates, pyramids, planet. Developments in national healthy and sustainable dietary guidelines: a state of play assessment*. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO).
- Fitzgerald, W (2011). Energy use of integral refrigerated containers in maritime transportation. *Energy Policy*, 39(4): 1885-1896.
- Fitzgerald, W., O. Howitt, and I. Smith. (2011). Greenhouse gas emissions from the international maritime transport of New Zealand's imports and exports. *Energy Policy*, 39(3): 1521–1531.
- Fresán, U., Martínez-Gonzalez, M.-A., Sabaté, J., and Bes-Rastrollo, M. (2018). The Mediterranean diet, an environmentally friendly option: evidence from the Seguimiento Universidad de Navarra (SUN) cohort. *Public health nutrition* 21(8), 1573-1582.
- Friel, S., Barosh, L.J., and Lawrence, M. (2014). Towards healthy and sustainable food consumption: an Australian case study. *Public health nutrition* 17(5), 1156-1166.
- Friel, S., Marmot, M., McMichael, A.J., Kjellstrom, T., and Vågerö, D. (2008). Global health equity and climate stabilisation: a common agenda. *The Lancet* 372(9650), 1677-1683.
- Gakidou, E., Afshin, A., Abajobir, A.A., Abate, K.H., Abbafati, C., Abbas, K.M., et al. (2017). Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *The Lancet* 390(10100), 1345-1422.
- Garnett, T. (2011). Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? *Food Policy* 36, S23-S32. doi: <https://doi.org/10.1016/j.foodpol.2010.10.010>.
- Garnett, T. (2014). Three perspectives on sustainable food security: efficiency, demand restraint, food system transformation. What role for life cycle assessment? *Journal of Cleaner Production* 73, 10-18.
- Garnett, T., Appleby, M., Balmford, A., Bateman, I., Benton, T., Bloomer, P., et al. (2014). "What is a sustainable healthy diet? A discussion paper". (Food Climate Research Network, University of Oxford).
- GCSD (2013). *The Sustainable Shopping Basket: a guide to better shopping* [Online]. German Council for Sustainable Development. [Accessed 2 Jul 2018].
- Glasman, L. R., & Albarracin, D. (2006). Forming attitudes that predict future behavior: A meta-analysis of the attitude-behavior relation. *Psychological bulletin*, 132(5), 778.
- Grivetti, L.E., and Ogle, B.M. (2000). Value of traditional foods in meeting macro-and micronutrient needs: the wild plant connection. *Nutrition Research Reviews* 13(1), 31-46.
- Groombridge, B. (1992). "The Convention on Biological Diversity.", 576-583.
- Gupta, J., Pouw, N.R.M., and Ros-Tonen, M.A.F. (2015). Towards an Elaborated Theory of Inclusive Development. *The European Journal of Development Research* 27(4), 541-559. doi: 10.1057/ejdr.2015.30.
- Gussow, J.D., and Clancy, K.L. (1986). Dietary guidelines for sustainability. *Journal of Nutrition Education* 18(1), 1-5. doi: [http://dx.doi.org/10.1016/S0022-3182\(86\)80255-2](http://dx.doi.org/10.1016/S0022-3182(86)80255-2).
- Gustavsson, J., Cederberg, C., Sonesson, U., Van Otterdijk, R., and Meybeck, A. (2011). *Global food losses and food waste*. Rome, Italy: FAO.
- Hales, S., Salmond, C., Town, G.I., Kjellstrom, T., and Woodward, A. (2000). Daily mortality in relation to weather and air pollution in Christchurch, New Zealand. *Australian and New Zealand journal of public health* 24(1), 89-91.
- Hallegatte, S., Bangalore, M., Bonzanigo, L., Fay, M., Kane, T., Narloch, U., et al. (2015). "Managing the Impacts of Climate Change on Poverty". Washington DC, World Bank).
- Hamm, M.W. (2008). Linking Sustainable Agriculture and Public Health: Opportunities for Realizing Multiple Goals. *Journal of Hunger & Environmental Nutrition* 3(2-3), 169-185. doi: 10.1080/19320240802243241.
- Harpe, S.E. (2015). How to analyze Likert and other rating scale data. *Currents in Pharmacy Teaching and Learning* 7(6), 836-850. doi: <https://doi.org/10.1016/j.cptl.2015.08.001>.
- HCofN (2011). "Guidelines for a healthy diet: the ecological perspective". (The Hague: Health Council of the Netherlands).
- He, F., Brinsden, H., and MacGregor, G. (2014). Salt reduction in the United Kingdom: a successful experiment in public health. *Journal of human hypertension* 28(6), 345.

- Heilig, G.K. (2012). World urbanization prospects: the 2011 revision. *United Nations, Department of Economic and Social Affairs (DESA), Population Division, Population Estimates and Projections Section, New York*, 14.
- Hoek, A.C., Pearson, D., James, S.W., Lawrence, M.A., and Friel, S. (2017). Shrinking the food-print: A qualitative study into consumer perceptions, experiences and attitudes towards healthy and environmentally friendly food behaviours. *Appetite* 108, 117-131. doi: <http://dx.doi.org/10.1016/j.appet.2016.09.030>.
- Hollingsworth, A. (2018). "Sustainable Diets: The Gulf Between Management Strategies and the Nutritional Demand for Fish," in *Handbook of Sustainability Science and Research.*, 711-725.
- Hollis, M. (2014). "Climate Change: IPCC Fifth Assessment Report New Zealand findings". (Wellington, NZ: New Zealand Climate Change Centre).
- Husband, A. (2013). Climate Change and the role of food price in determining obesity risk/Drewnowski et al. respond. *American Journal of Public Health* 103(1), E2.
- IPCC (2018a). *Global Warming of 1.5°C. An IPCC special report on the impacts of global warming of 1.5°C above pre-industrialised levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development and efforts to eradicate poverty* [Online]. <http://www.ipcc.ch/report/sr15/> [Accessed 9 Sep 2018].
- IPCC (2018b). *Intergovernmental Panel on Climate Change. Press Release: Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C approved by governments* [Online]. http://www.ipcc.ch/news_and_events/pr_181008_P48_spm.shtml. [Accessed 8 Sep 2018].
- Israel, G. D. (1992). Determining sample size.
- IUCN (2018). *The IUCN Red List of Threatened Species. Version 2018-2*. [Online]. Available: <http://www.iucnredlist.org>. [Accessed 12 October 2018].
- James, S.W., Friel, S., Lawrence, M.A., Hoek, A.C., and Pearson, D. (2018). Inter-sectoral action to support healthy and environmentally sustainable food behaviours: a study of sectoral knowledge, governance and implementation opportunities. *Sustainability Science* 13(2), 465-477. doi: 10.1007/s11625-017-0459-8.
- Jones, A., Magnusson, R., Swinburn, B., Webster, J., Wood, A., Sacks, G., et al. (2016). Designing a healthy food partnership: lessons from the Australian food and health dialogue. *BMC public health* 16(1), 651.
- Jones, R., Volgliono, C., Burlingame, B (2019). "Sustainable Diets and Food-based Dietary Guidelines," in *Sustainable Diets: Linking Nutrition and Food Systems* ed. B. B, S, Dernini. (CAB International), 158.
- Joyce, A., Hallett, J., Hannelly, T., and Carey, G. (2014). The impact of nutritional choices on global warming and policy implications: examining the link between dietary choices and greenhouse gas emissions. *Energy and Emission Control Technologies* 2, 33-43.
- Kajikawa, Y., Ohno, J., Takeda, Y., Matsushima, K., and Komiyama, H. (2007). Creating an academic landscape of sustainability science: an analysis of the citation network. *Sustainability Science* 2(2), 221.
- Kasunic, M. (2005). *Designing an effective survey*. Carnegie-Mellon University Pittsburgh PA Softwards Engineering Inst.
- Kearney, J. (2010). Food consumption trends and drivers. *Philosophical Transactions of the Royal Society of London B: Biological Sciences* 365(1554), 2793-2807.
- Kickbusch, I. (2008). *Policy innovation for health*. Springer Science & Business Media.
- Lal, A., Moodie, M., Ashton, T., Siahpush, M., and Swinburn, B. (2012). Health care and lost productivity costs of overweight and obesity in New Zealand. *Australian and New Zealand journal of public health* 36(6), 550-556.
- Lang, T., Barling, D., and Caraher, M. (2009). *Food Policy: Integrating health, environment and society*. London, UK: Oxford Scholarship Online.
- Lang, T., Mason, P. (2019). Sustainable diets: a bundle of problems (not one) in search of answers. 10.1079/9781786392848.0001.

- Livsmedelsverket, National Food Administration (Sweden) (2015). Find your Way to Eat Greener, Not Too Much and be Active. Livsmedelsverket / National Food Administration, Stockholm, Sweden, 26.
- Leining, C. (2015). *New Zealand's Journey Toward a Low-emission Future: Today's Climate Change Landscape*. Wellington, NZ: Motu Economic and Public Policy Research.
- Louie, J.C.Y., and Rangan, A.M. (2018). No need to change dairy food dietary guidelines yet. *The Lancet* 392(10161), 2242-2244.
- Macdiarmid, J.I., Douglas, F., and Campbell, J. (2016). Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet. *Appetite* 96, 487-493.
- Macdiarmid, J.I., Kyle, J., Horgan, G.W., Loe, J., Fyfe, C., Johnstone, A., et al. (2012). Sustainable diets for the future: can we contribute to reducing greenhouse gas emissions by eating a healthy diet?-. *The American journal of clinical nutrition* 96(3), 632-639.
- Magdoff, F. (2012). Food as a Commodity. *Monthly Review* 63(8), 15-22.
- Magni, P., Bier, D.M., Pecorelli, S., Agostoni, C., Astrup, A., Brighenti, F., et al. (2017). Perspective: Improving Nutritional Guidelines for Sustainable Health Policies: Current Status and Perspectives. *Advances in Nutrition: An International Review Journal* 8(4), 532-545. doi: 10.3945/an.116.014738.
- Marteau, T.M., Hollands, G.J., Shemilt, I., and Jebb, S.A. (2015). Downsizing: policy options to reduce portion sizes to help tackle obesity. *BMJ* 351, h5863.
- MBIE. (2014). New Zealand Energy Balance Tables. Ministry of Business, Innovation and Employment.
- McCarthy, J.J., Canziani, O.F., Leary, N.A., Dokken, D.J., and White, K.S. (2001). *Climate change 2001: impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press.
- Mebratu, D. (1998). Sustainability and sustainable development: historical and conceptual review. *Environmental impact assessment review* 18(6), 493-520.
- Melina, V., Craig, W., and Levin, S. (2016). Position of the Academy of Nutrition and Dietetics: vegetarian diets. *Journal of the Academy of Nutrition and Dietetics* 116(12), 1970-1980.
- Merrigan, K., Griffin, T., Wilde, P., Robien, K., Goldberg, J., and Dietz, W. (2015). Designing a sustainable diet. *Science* 350(6257), 165-166. doi: 10.1126/science.aab2031.
- Metcalf, S., Woodward, A., and Macmillan, A. (2009). Why New Zealand must rapidly halve its greenhouse gas emissions. *The New Zealand Medical Journal (Online)* 122(1304).
- MfE (2013). "New Zealand's Greenhouse Gas Inventory and Net Position Report 1990-2011, Snapshot April 2013; New Zealand's Greenhouse Gas Inventory. Wellington: Ministry for the Environment". (Wellington, NZ: Ministry for the Environment).
- MfE (2014). "New Zealand's greenhouse gas inventory 1990-2012". Wellington, NZ: Ministry for the Environment Wellington).
- MfE (2017). "New Zealand's Seventh National Communication under the United Nations Framework Convention on Climate Change and the Kyoto Protocol". (Wellington, NZ: Ministry for the Environment).
- MfE (2018). "Climate Change Projections for New Zealand: Atmosphere Projections Based on Simulations from the IPCC Fifth Assessment". 2nd ed. (Wellington, NZ: Ministry for the Environment).
- MOH (2011). "A focus on nutrition: Key findings of the 2008/09 New Zealand Adult Nutrition Survey". (Wellington, NZ: MOH).
- MOH (2015). *Eating and activity guidelines for New Zealand adults* [Online]. Wellington, NZ: Ministry of Health website. Available: <https://www.health.govt.nz/publication/eating-and-activity-guidelines-new-zealand-adults> [Accessed 3 Oct 2017].
- MOH, B. (2014). "Dietary Guidelines for the Brazilian Population". (Ministry of Health, Brazil).
- Mondelaers, K., Aertsens, J., and Van Huylbroeck, G. (2009). A meta-analysis of the differences in environmental impacts between organic and conventional farming. *British food journal* 111(10), 1098-1119.

- Monteiro, C.A., Cannon, G., Moubarac, J.-C., Levy, R.B., Louzada, M.L.C., and Jaime, P.C. (2018). The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutrition* 21(1), 5-17.
- MPI (2018). *New Zealand Total Diet Study 2016* [Online]. MPI, Wellington. [Accessed 6 Sep 2018].
- NAoS (2017). *Redesigning the process for establishing the Dietary Guidelines for Americans*. Washington, DC: National Academies of Sciences, Engineering, Medicine: National Academies Press.
- NHMRC, N. (2013). "Australian dietary guidelines", in: *National Health and Medical Research Council, National Resource Management Ministerial Council*. (Canberra, AU: National Health and Medical Research Council).
- Norman, G. (2010). Likert scales, levels of measurement and the "laws" of statistics. *Advances in Health Sciences Education* 15(5), 625-632. doi: 10.1007/s10459-010-9222-y.
- O'Neill, D.W., Fanning, A.L., Lamb, W.F., and Steinberger, J.K. (2018). A good life for all within planetary boundaries. *Nature Sustainability* 1(2), 88.
- OECD (2017a). *OECD Environmental Performance Reviews: New Zealand 2017*.
- OECD (2017b). "OECD environmental performance reviews: New Zealand 2017". (New York, NY: OECD).
- Oshiro, J., Adyatni, I., O'Connor, L., and Savaiano, D. (2018). Sustainable Eating Patterns Should Be Part of the Dietary Guidelines for Americans. *Nutrition Today* 53(2), 79-84. doi: 10.1097/NT.0000000000000266.
- Parnell, W., Wilson, N., Thomson, C., Mackay, S., and Stefanogiannis, N. (2011). A focus on nutrition: key findings of the 2008/09 New Zealand adult nutrition survey. *Wellington, NZ: Ministry of Health*.
- Parnell, W.R., Reid, J., Wilson, N.C., McKenzie, J., and Russell, D.G. (2001). Food security: is New Zealand a land of plenty? *New Zealand Medical Journal* 114(1128), 141.
- Parry, M.L., Rosenzweig, C., Iglesias, A., Livermore, M., and Fischer, G. (2004). Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global environmental change* 14(1), 53-67.
- Perignon, M., Masset, G., Ferrari, G., Barré, T., Vieux, F., Maillot, M., et al. (2016). How low can dietary greenhouse gas emissions be reduced without impairing nutritional adequacy, affordability and acceptability of the diet? A modelling study to guide sustainable food choices. *Public health nutrition* 19(14), 2662-2674.
- Phillips, B.F., and Pérez-Ramírez, M. (2017). *Climate Change Impacts on Fisheries and Aquaculture: A Global Analysis*. West Sussex, UK: John Wiley & Sons.
- Pimentel, D., and Pimentel, M. (2003). Sustainability of meat-based and plant-based diets and the environment. *The American Journal of Clinical Nutrition* 78(3), 660S-663S. doi: 10.1093/ajcn/78.3.660S.
- Popkin, B.M. (2003). The nutrition transition in the developing world. *Development policy review* 21(5-6), 581-597.
- Popkin, B.M. (2006). Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases-. *The American journal of clinical nutrition* 84(2), 289-298.
- Popkin, B.M., Adair, L.S., and Ng, S.W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutrition reviews* 70(1), 3-21.
- Quiggin, J. (2010). Drought, climate change and food prices in Australia. *Melbourne, AU: Australian Conservation Foundation*.
- Ramankutty, N., and Foley, J.A. (1999). Estimating historical changes in global land cover: Croplands from 1700 to 1992. *Global biogeochemical cycles* 13(4), 997-1027.
- Rayner, G., and Lang, T. (2012). *Ecological public health*. New York, NY.
- Reynolds, L.P., Wulster-Radcliffe, M.C., Aaron, D.K., and Davis, T.A. (2015). Importance of Animals in Agricultural Sustainability and Food Security, 2. *The Journal of nutrition* 145(7), 1377-1379.
- Ridgway, E.M., Lawrence, M.A., and Woods, J. (2015). Integrating Environmental Sustainability Considerations into Food and Nutrition Policies: Insights from Australia's National Food Plan. *Frontiers in Nutrition* 2(29). doi: 10.3389/fnut.2015.00029.

- Ritchie, H., Reay, D.S., and Higgins, P. (2018). The impact of global dietary guidelines on climate change. *Global Environmental Change* 49, 46-55.
- Rockström, J., Stordalen, G.A., and Horton, R. (2016). Acting in the anthropocene: the EAT–Lancet commission. *The Lancet* 387(10036), 2364-2365.
- Rutter, J., Marshall, E., and Sims. (2011). *The “S” Factors: Lessons from IFG’s Policy Success Reunions*. Institute for Government, London, 124.
- Sabate, J., Harwatt, H., and Soret, S. (2016). Environmental Nutrition: A New Frontier for Public Health. *American Journal of Public Health* 106(5), 815-821. doi: 10.2105/ajph.2016.303046.
- Sabate, J., and Soret, S. (2014). Sustainability of plant-based diets: back to the future. *The American journal of clinical nutrition* 100(suppl_1), 476S-482S.
- Scarborough, P., Appleby, P.N., Mizdrak, A., Briggs, A.D.M., Travis, R.C., Bradbury, K.E., et al. (2014). Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK. *Climatic Change* 125(2), 179-192. doi: 10.1007/s10584-014-1169-1.
- Schmidhuber, J., and Shetty, P. (2005). Nutrition transition, obesity and noncommunicable diseases: drivers, outlook and concerns. *SCN news* 29(13-19).
- Scott, P. (2017). Global panel on agriculture and food systems for nutrition: food systems and diets: facing the challenges of the 21st century. *Food Security: The Science, Sociology and Economics of Food Production and Access to Food* 9(3), 653-654.
- Searchinger, T., Hanson, C., Ranganathan, J., Lipinski, B., Waite, R., Winterbottom, R., et al. (2014). "Creating a sustainable food future. A menu of solutions to sustainably feed more than 9 billion people by 2050.", in: *World resources report 2013-14: interim findings*. (Washington, DC: World Resource Institute).
- Seed, B. (2015). Sustainability in the Qatar national dietary guidelines, among the first to incorporate sustainability principles. *Public health nutrition* 18(13), 2303-2310.
- Seufert, V., Ramankutty, N., and Foley, J.A. (2012). Comparing the yields of organic and conventional agriculture. *Nature* 485(7397), 229.
- Sivacek, J., and Crano, W.D. (1982). Vested interest as a moderator of attitude–behavior consistency. *Journal of Personality and Social Psychology* 43(2), 210.
- Smith, K.R., Woodward, A., Campbell-Lendrum, D., Chadee, D.D., Honda, Y., Liu, Q., et al. (2014). "Human health: impacts, adaptation, and co-benefits. Chapter 11 in Climate Change 2014: Impacts, Adaptation, and Vulnerability", in: *Climate change*. (Cambridge University Press, Cambridge, UK and NYC).
- Speedy, A.W. (2003). Global production and consumption of animal source foods. *The Journal of nutrition* 133(11), 4048S-4053S.
- Springmann, M., Godfray, H.C.J., Rayner, M., and Scarborough, P. (2016). Analysis and valuation of the health and climate change cobenefits of dietary change. *Proceedings of the National Academy of Sciences* 113(15), 4146-4151. doi: 10.1073/pnas.1523119113.
- Stanaway, J.D., Afshin, A., Gakidou, E., Lim, S.S., Abate, D., Abate, K.H., et al. (2018). Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet* 392(10159), 1923-1994.
- StatsNZ (2016). *Business Demography Statistics: Geographic units by region and industry 2000-18* [Online]. Auckland, NZ: Stats NZ Tauranga Aotearoa. Available: <http://nzdotstat.stats.govt.nz/wbos/Index.aspx?DataSetCode=TABLECODE7601> [Accessed].
- Steffen, W., Broadgate, W., Deutsch, L., Gaffney, O., and Ludwig, C. (2015a). The trajectory of the Anthropocene: the great acceleration. *The Anthropocene Review* 2(1), 81-98.
- Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., et al. (2015b). Planetary boundaries: Guiding human development on a changing planet. *Science* 347(6223), 1259855.
- Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M., Rosales, M., et al. (2006). *Livestock's long shadow: environmental issues and options*. Rome, Italy: Food & Agriculture Org.

- Sterling, E.J., Betley, E., Sigouin, A., Gomez, A., Toomey, A., Cullman, G., et al. (2017). Assessing the evidence for stakeholder engagement in biodiversity conservation. *Biological Conservation* 209, 159-171.
- Sullivan, G.M., and Artino, A.R. (2013). Analyzing and Interpreting Data From Likert-Type Scales. *Journal of Graduate Medical Education* 5(4), 541-542. doi: 10.4300/JGME-5-4-18.
- Tilman, D., and Clark, M. (2014). Global diets link environmental sustainability and human health. *Nature* 515(7528), 518-522. doi: 10.1038/nature13959.
- Tobias, M. (2016). *Health Loss in New Zealand 1990-2013: A Report from the New Zealand Burden of Diseases, Injuries and Risk Factors Study*. Wellington, NZ: Ministry of Health.
- Toledo, A., and Burlingame, B. (2006). Biodiversity and nutrition: A common path toward global food security and sustainable development. *Journal of food composition and analysis* 19(6-7), 477-483.
- Toman, M. (1995). "The Difficulty in Defining Sustainability: A Survey of Ecological Economics". (Washington DC: Island Press).
- TWB (2012). "The World Bank Report: Turn Down The Heat: Why a 4°C Warmer World Must be Avoided. A Report for the World Bank by the Potsdam Institute for Climate Impact Research and Climate Analytics". (Washington, DC).
- UN (2015a). "New Zealand's Intended Nationally Determined Contribution: UN Framework Convention on Climate Change 2015".).
- UN (2015b). Paris Agreement: United Nations framework convention on climate change. *Paris, France: UN*.
- UN (2015c). "Transforming Our World: The 2030 Agenda for Sustainable Development. Draft resolution referred to the United Nations summit for the adoption of the post-2015 development agenda by the General Assembly at its sixty-ninth session.". (Rome, Italy: UN).
- UNSCN (2017). "UNSCN Annual Report ". (Rome, Italy: UNSCN: United Nations System Standing Committee on Nutrition).
- Vermeir, I., and Verbeke, W. (2006). Sustainable food consumption: Exploring the consumer "attitude-behavioral intention" gap. *Journal of Agricultural and Environmental ethics* 19(2), 169-194.
- Vos, R.O. (2007). Defining sustainability: a conceptual orientation. *Journal of Chemical Technology & Biotechnology: International Research in Process, Environmental & Clean Technology* 82(4), 334-339.
- Waterlander, W.E., Ni Mhurchu, C., Eyles, H., Vandevijvere, S., Cleghorn, C., Scarborough, P., et al. (2018). Food Futures: Developing effective food systems interventions to improve public health nutrition. *Agricultural Systems* 160, 124-131. doi: <https://doi.org/10.1016/j.agsy.2017.01.006>.
- Wellesley, L., Happer, C., and Froggatt, A. (2015). "Chatham House Report: Changing Climate, Changing Diets: Pathways to Lower Meat Consumption". (London, UK: CHatham House, The Royal Institute of International Affairs).
- Wheeler, S.A. (2008). What influences agricultural professionals' views towards organic agriculture? *Ecological Economics* 65(1), 145-154. doi: <https://doi.org/10.1016/j.ecolecon.2007.05.014>.
- Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A.G., de Souza Dias, B.F., et al. (2015). Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation-Lancet Commission on planetary health. *The Lancet* 386(10007), 1973-2028.
- Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A. and Jonell, M. (2019). Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, 393(10170), 447-492.
- WHO (2017). *Ambition and action in nutrition: 2016-2025*. Geneva, Switzerland: World Health Organization.
- WHO (2018). *Obesity and overweight* [Online]. Geneva, Switzerland: World Health Organisation. Available: <https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight> [Accessed 2.11.18].
- Wolk, A. (2017). Potential health hazards of eating red meat. *Journal of internal medicine* 281(2), 106-122.

- Woodward, A., Hales, S., and De Wet, N. (2001). Climate change: potential effects on human health in New Zealand. *Wellington, NZ: Ministry for the Environment*.
- Wynes, S., and Nicholas, K.A. (2017). The climate mitigation gap: education and government recommendations miss the most effective individual actions. *Environmental Research Letters* 12(7), 074024.

Appendices

Appendix A: Supplementary Methods

Validation, editing and imputation of the data were completed by editing individual records as discussed below. Question 4, concerning which sector (Health, Environment or Agriculture) the participants identified as working under, was used to identify professionals of interest to the survey. Respondents who selected their sector as “other” were edited by secondary validation; that is, their answer to the next question or previous response was used to determine which sector they belonged to. In addition, valuable subjective source, that is, the *Australian and New Zealand Standard Industrial Classification (ANZSIC) (2006)* was used to categorise responses into the correct sector. The most common use for this was respondents who selected “Other” then specified “Horticulture” in the comment box which, for the purposes of this study, falls under the “Agriculture” sector. An additional sub-sector group was created, labelled “Agriculture – other” for respondents who identified as working for more than one agricultural sub-sector or one that was not an available option, such as “bees”. Errors in data entry were screened using the frequency tools in SPSS. Missing data was labelled as “999”. Following this step, all cases were within the expected ranges (labels). Following data cleaning, five respondents’ surveys could not be used as they were irrelevant observations or could not be clearly sorted into one of the sectors (health, agriculture, environment).

The *Explore* procedure in SPSS Statistics is a software package used for interactive, or batched, statistical analysis (SPSS) was used to assess normality. Although some of the data were determined as non-normal, evidence shows that parametric analytical approaches are acceptable provided certain criteria are met (Harpe, 2015). As means are often of limited value unless the data follow a classic normal distribution, a frequency distribution of responses has first been used to describe the data, and means have been reported to one decimal place for further description (Sullivan and Artino, 2013). Non-parametric tests were simultaneously run and shown to produce the same inferential results and prove parametric statistics were robust with respect to violations of these assumptions (Norman, 2010).

Further, it has been shown that parametric tests not only can be used with ordinal data, such as data from Likert scales, but also that parametric tests are generally more robust than nonparametric tests. That is, parametric tests tend to give “the right answer” even when statistical assumptions—such as a normal distribution of data—are violated, even to an extreme degree.⁴ Thus, parametric tests are sufficiently robust to yield largely unbiased answers that are acceptably close to “the truth” when analyzing Likert scale responses. (ref - Norman G. Likert scales, levels of measurement and the “laws” of statistics. *Adv Health Sci Educ Theory Pract.* 2010;15(5):625–632.)

However, means are often of limited value unless the data follow a classic normal distribution and a frequency distribution of responses will likely be more helpful. Therefore, this study has chosen to present both percentages of responses as well as means to fully describe the data.

An analysis of covariance predicting agreement with the inclusion of sustainability characteristics in the *Eating and Activity Guidelines for New Zealand Adults*. This was conducted for the demographic variables which had significant association with the Likert-scale questions as seen in Table 4.

Appendix A; Table 1. Agreement to sustainability statements by gender, age and education level.

Sustainability statement	Gender collapsed (P-value)	Age collapsed (P-value)	Education collapsed – Graduate degree (P-value)	Education – highschool	Education – postgraduate P

The world's current food system is sustainable	0.00*	0.028*	0.000*	0.00*	0.017*
New Zealand's current food system is sustainable	0.001*	0.227	0.024*	0.024*	0.000*
New Zealand needs to adopt more/better agro-ecological farming practices	0.043*	0.424	0.546	0.702	0.174
I am familiar with the 2015 "Eating and Activity Guidelines for New Zealand Adults"	0.000*	0.508	0.004*	0.053*	0.000*
Sustainability recommendations should be included in the "Eating and Activity Guidelines for Adults"	0.065	0.121	0.410	0.483	0.320
Promotion of diet diversity/variety of whole foods	0.909	0.515	0.349	0.656	0.979
Promotion of plant-based diets	0.003*	0.075	0.000*	0.000*	0.000*
To limit red meat consumption as per recommendations	0.000*	0.087	0.000*	0.000*	0.000*
To limit processed meat consumption as per recommendations	0.001*	0.099	0.000*	0.001*	0.001*
To consume recommended serves of dairy products	0.163	0.878	0.780	0.866	0.553
Promotion of sustainable seafood consumption	0.348	0.670	0.904	0.873	0.830
To limit/reduce ALL processed foods high in fat, salt and sugar as per recommendations	0.000*	0.263	0.312	0.492	0.814
To purchase and support local food produce	0.005*	0.839	0.074	0.127	0.740
To purchase and support seasonal food produce	0.016	0.873	0.120	0.313	0.803
To purchase and support organic food produce	0.012*	0.703	0.626	0.895	0.574
Standards for the ethical treatment of livestock	0.013*	0.186	0.187	0.445	0.030*
To reduce food waste	0.869	0.452	0.228	0.498	0.615
Promotion of sustainable lifestyle behaviours (for example, physical activity)	0.861	0.538	0.874	0.961	0.982

I support country of origin labelling of foods	0.051	0.970	0.153	0.376	0.922
I support labelling foods with New Zealand Geographic Indicators	0.318	0.176	0.737	0.884	0.744

* identifies level of significance $P < 0.05$

Two variables were created for 'Education'; High School 1=Yes 0=No and Postgrad 1=Yes 0=No. No variable was created for Bachelors as that is the reference category. An ANCOVA was then run with covariates; gender, age, high school and postgrad and the fixed factor was sector. The dependent variable was the item score of each statement e.g. I support labelling foods with New Zealand Geographic Indicators.

Results show that there is a statistically significant difference between gender groups and level of agreement as determined by one-way ANOVA; "The world's current food system is sustainable", "New Zealand's current food system is sustainable", "New Zealand needs to adopt more/better agro-ecological farming practices", "I am familiar with the 2015 "Eating and Activity Guidelines for New Zealand Adults", "Promotion of plant-based diets", "To limit red meat consumption as per recommendations", "To limit processed meat consumption as per recommendations". There is a statistically significant difference between age groups and level of agreement as determined by one-way ANOVA; "The world's current food system is sustainable", "To limit red meat consumption as per recommendations", "I support labelling foods with New Zealand Geographic Indicators". There is a statistically significant difference between education groups and level of agreement as determined by one-way ANOVA; "The world's current food system is sustainable", "New Zealand's current food system is sustainable", "I am familiar with the 2015 "Eating and Activity Guidelines for New Zealand Adults", "Promotion of plant-based diets", "To limit red meat consumption as per recommendations", "To limit processed meat consumption as per recommendations". Therefore, ANCOVAs were run to detect a difference in means of the sector levels of agreements whilst controlling for covariates.

Table 2. Sector associations or governing bodies directly contacted

Agriculture	Environment	Health
Federated Farmers	Royal Society of NZ	Nutrition Society of New Zealand
Sanford	Ministry for the Environment	High Performance Sport NZ
T&G NZ (originally Turners and Growers)	Environmental Defence Society NZ	Canterbury District Health Board
Landcorp Farming Limited NZ	Aquaculture NZ	
Meat Industry Association of New Zealand	Environment and Conservation Organisations of Aotearoa New Zealand	Dietitians NZ
Ministry of Primary Industries		Counties Manukau Health
Horticulture New Zealand	Environmental Protection Authority	New Zealand Medical Association
Beef + Lamb New Zealand		
Poultry Industry Association of New Zealand	World Wildlife Fund NZ	Public Health Association of NZ
Mr Apple NZ	Department of Conservation (DoC)	Pegasus Health: Primary Health Services
The New Zealand King Salmon Co Ltd.	Green Peace NZ	Waitemata District Health Board
Vegetables (VegFed)	Green Party of Aotearoa	Auckland District Health Board
	Sustainable Business Network	
	Te Ngahere	
	New Zealand Biosecurity Services Limited	
	National Institute of Water and Atmospheric Research (NIWA)	
	Ministry of Primary Industries	
	Environment Network Manawatu	
	Eco Centre Kaitaia	

Appendix B: Participant Information Sheet and Participant Consent Form

Multi-sectoral opinion towards introducing sustainability guidelines into NZ's dietary guidelines

Thank you for participating in this study. The survey will take approximately 3 minutes to complete. To learn more about the study, please read on.

OR

To give consent to participate in this study and go straight to the survey, click 'OK' at the bottom of this page.

Closing date: 01/08/2018

Description

There is increasingly robust evidence to suggest that dietary patterns that have low environmental impacts can also be consistent with good health.

The FAO and Biodiversity International definition of sustainable diets is “those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources”.

Consequently, some international guidelines have begun to include descriptions of both the environmental and health benefits of dietary choices such as limiting red meat and the overconsumption of all foods.

Key stakeholders' perspectives are vital when designing relevant and appropriate recommendations as part of an endeavour to shift to more sustainable food systems and diets. This study seeks key stakeholders' perspectives of the possible integration of sustainability recommendations in the “Eating and Activity Guidelines for New Zealand Adults”.

The guidelines provide evidence-based population health advice on healthy eating and being physically active. The guideline is written for health practitioners and others who provide advice on nutrition and physical activity for New Zealand adults. See: <https://www.health.govt.nz/publication/eating-and-activity-guidelines-new-zealand-adults>

Invitation to Participate and Your Rights

Approximately 100 participants will take part in this study who are:

- over 18 years old
- professionals working in either the Health, Agricultural or Environment sectors in New Zealand
- competent in reading English
- willing to complete a short online survey

Your participation in this study is voluntary and you may withdraw at any time. You are not obliged to answer any question you do not wish to answer.

There are no foreseen risks or discomforts to you by involving yourself in this study. There is no direct benefit to you for participating in this study. Your responses will not be matched with your identity and will be anonymous, and your responses to the questionnaire will be used for research purposes only.

Consent:

Should you choose to participate, please indicate your consent. You may withdraw your consent at any time without penalty.

Authorisation:

I have read the procedure described above. I voluntarily agree to participate in the procedure and I have read a copy of this description. I am aware that my responses will remain confidential and that I may decline to participate at any time.

By clicking ‘Ok’, you are consenting to participate in this study.

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University’s Human Ethics Committees. The researcher(s) named above are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you wish to raise with someone other than the researcher(s), please contact Dr Brian Finch, Director, Research Ethics, telephone 06 356 9099 extn 86015, email: humanethics@massey.ac.nz. To give consent to participate in this study and go straight to the survey, click “OK” at the bottom of this page.

Appendix C: Questionnaire

1. What is your gender?

- Male
- Female
- Other

2. What is your age?

- 18 to 24
- 25 to 34
- 35 to 44
- 45 to 54
- 55 to 64
- 65 to 74
- 75 or older

3. What is the highest level of education you have completed (or are currently completing)?

- No qualification
- High school
- Bachelor's Degree
- Post-graduate and honours degrees
- Overseas secondary school qualification

4. Which professional sector do you identify with?

- Environmental
- Agriculture - Meat, Dairy, Seafood and Aquaculture
- Health - Private, NGOs, DHBs
- Other (please specify)

5. Within this sector, which sub-sector do you identify with?

- Agriculture - Meat
- Agriculture - Dairy
- Agriculture - Seafood and aquaculture
- Agriculture - Horticulture
- Health - Nutrition
- Health - Other
- Environment
- Other (please specify)

6. Please state whether you agree or disagree with the following statements:

Strongly Don't Strongly
Agree Agree know Disagree Disagree

The world's current food system is sustainable

New Zealand's current food system is sustainable

New Zealand needs to adopt more/better agro-ecological farming practices

I am familiar with the 2015 'Eating and Activity Guidelines for New Zealand Adults'

Sustainability recommendations should be included in the 'Eating and Activity Guidelines for Adults'

7. The following characteristics of a sustainable diet should be included and linked to both human and environmental health in the 'Eating and Activity Guidelines for New Zealand Adults':

Strongly Don't
agree Agree Know Disagree Strongly Disagree

Promotion of diet diversity/variety of whole foods

Promotion of plant-based diets

To limit red meat consumption as per recommendations

Strongly Don't
agree Agree Know Disagree Strongly Disagree

To limit processed meat consumption as per recommendations

To consume recommended serves of dairy products

Promotion of sustainable seafood consumption

To limit/reduce ALL processed foods high in fat, salt and sugar as per recommendations

To purchase and support local food produce

To purchase and support seasonal food produce

To purchase and support organic food produce

Standards for the ethical treatment of livestock

To reduce food waste

Promotion of sustainable lifestyle behaviours (for example, physical activity)

8. Please state your agreement with the following statements:

Strongly Don't Strongly
Agree Agree Know Disagree Disagree

I support country of origin labelling of foods

I support labelling foods with New Zealand Geographic Indicators (e.g. Keri Keri oranges, Pukekohe potatoes, Gimblett Gravels wine)

Survey Complete!

If you would like to provide any additional comments or feedback please email R.Jones@massey.ac.nz

Appendix D: Chapter 16: Sustainable Diets

Chapter 16: Sustainable Diets and Food-based Dietary Guidelines Chapter in Sustainable Diets; Linking Nutrition and Food Systems (Jones et al, 2019)

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16 Sustainable Diets and Food-based Dietary Guidelines

Rebekah Jones, Christopher Vogliano and Barbara Burlingame

Abstract

Food-based dietary guidelines (FBDGs) have been developed by countries around the world as simple policy instruments to promote better diets for individuals and populations. The guidance historically has been based on country-specific, diet-related morbidity and mortality. As the environmental impact of food consumption and production push planetary boundaries, the case for inclusion of elements of environmental sustainability into FBDGs becomes compelling. Issues addressed include biodiversity, plant-based diets, meat and dairy consumption and production, sustainable fish consumption, processed foods, local, seasonal and organic production, standards of ethical treatment for livestock, waste and lifestyle behaviours. Examples from official FBDGs are presented, along with examples of quasi-official guidelines. Challenges and failures are also discussed, related to lack of political support and vested interests. With consideration given to all the international agreements signed by nations related to both nutrition and environmental sustainability, the logical integration should yield country-specific sustainable FBDGs.

Introduction

Food-based dietary guidelines (FBDGs) have a long history in providing basic and simple reference standards for healthy eating. They are recommendations and advice given to the public on foods, food groups and dietary patterns to encourage adequate nutrient intakes, promote overall health and prevent chronic diseases. In addition, they are often used as a basis for health and agricultural policies and nutrition education programmes.

Ancient Greek and Roman philosophers can be credited with developing some of the earliest iterations of FBDGs. Plato's writings from the 5th and 4th century BC detail the elements of a healthy diet and the importance of moderation, with recommendations that still appear in

modern-day versions of FBDGs. Over the next two millennia, and particularly after the invention of the printing press in the 15th century, physicians and philosophers alike were expanding their dietary advice. Again, moderation was recommended by most, and food safety, more than chronic disease, was an overarching theme (Albala, 2002). Sustainability issues were not typically featured.

At the end of the 19th century, one of the earliest university-level nutrition programmes was developed at the Massachusetts Institute of Technology (MIT) by Ellen Swallow Richards, a chemist and MIT's first female instructor. She is credited with introducing the word 'ecology' into the English language and establishing the curriculum for 'human ecology', with nutrition encompassing health, agriculture and environ-

mental sciences. Her many publications presented dietary guidelines integrated with guidelines for environmental sustainability. For Richards (1904), one of the pioneers of sustainable diets, there was no separation between human health and environmental health (Burlingame, 2014).

One of the earliest visual representations of FBDGs comes from the early 20th century in the USA, during the period of World War I. Fig. 16.1 shows a poster from the US Food Administration, the predecessor of the US Department of Agriculture, which lists several simple recommendations for the general public for acquiring and consuming food. The focus was mainly on food waste, with recommendations that have been absent for decades but are now re-appearing in very recent versions of sustainable FBDGs, e.g. use less meat, buy local foods and minimize food waste. However, for most of the 20th century, as agriculture became more industrialized and diets became more reliant on processed and convenience foods, the environmental impact of food consumption was not addressed in the study of nutrition, or in FBDGs.

The topic of environmental sustainability was re-emerge briefly in the 1980s. Cassow and Chaney (1986) published a paper, 'Dietary guidelines for sustainability', in which they argue:

... information on the relationship between human health and food choices is not a sufficient basis for nutrition education. In our time, educated consumers need to make food choices that not only enhance their own health but also contribute to the protection of our natural resources. Therefore, the content of nutrition education needs to be broadened and enriched not solely by medical knowledge, but also by information arising from disciplines such as economics, agriculture, and environmental science.

Unfortunately, this call for action was largely ignored by the nutrition community. FBDGs were being developed by governments and presented to the public, with little or no consideration of sustainability issues.

The era of sustainable development, which was hastened by the 1987 United Nations report, 'Our Common Future', also known as the Brundtland Report, brought environmental sustainability into sharp focus for the United Nations and its member nations. The sustainable development framework recognized both present and future generations, and the equal importance of people



Fig. 16.1. Poster from the US Food Administration, 1917.

and planet. But again, for the most part, FBDGs were not building on this foundation. By the end of the 20th century, more than 100 countries had FBDGs presented as published food guides, posters and infographics, often depicting food pyramids, food plates and other symbolic representations. They provided a framework for nutrition education programmes and informed policies in health and agriculture, but sustainability recommendations were, for the most part, absent.

However, in the first decade of the 21st century, with heightened awareness of environmental issues, a more holistic view was being applied to FBDGs. Moving from observational study, the mutually dependent relationships between nutrition, human health and planetary health were being recognized and brought into nutrition policies and programmes, and the first modern examples of sustainable FBDGs were produced.

The Case for Sustainability in Food-based Dietary Guidelines

The Brundtland Report (Brundtland, 1987) defined sustainability as sustainable development, and sustainable development as 'development that meets the needs of the present without

158

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Sustainable Diets and Food-based Dietary Guidelines

159

Gussow, J.D. and Clancy, K.L. (1986) Dietary guidelines for sustainability. *Journal of Nutrition Education* 18(1), 1-5.

Gustavsson, J., Cederberg, C., Sonesson, U., Van Otterdijk, R. and Meybeck, A. (2011) Global Food Losses and Food Waste. Food and Agriculture Organization of the United Nations, Rome, Italy, pp. 1-38.

HUPE (2016) Sustainable agricultural development for food security and nutrition: what role for livestock? A Report by the High Level Panel of Experts on Food Security and Nutrition to the Committee on World Food Security. Available at <http://www.fao.org/documents/report/10-dalaboration-processer/> (accessed 13 March 2018).

IFMed (2015) Mediterranean Diet Pyramid v. 4.0. Available at https://dietsandnutrition.com/gramdiets/IFMed_INGLES.pdf (accessed 3 March 2018).

Jackson, J.B., Kirby, M.X., Bergen, W.H., Bjornell, K.A., Bastford, L.W., et al. (2001). Historical overfishing and the recent collapse of coastal ecosystems. *Science* 293(5520), 629-637.

Jansen, M.C., Bueno-de-Mesquita, H.B., Peeters, E.J., Stegenga, M.T., Kok, F.J. and Kromhout, D. (2004) Quantity and variety of fruit and vegetable consumption and cancer risk. *Nutrition and Cancer* 46(2), 142-148.

Karl, A.K., Schatzkin, A., Harris, T.B., Ziegler, R.G. and Block, G. (1993) Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey. *Epidemiologic Follow-up Study, The American Journal of Clinical Nutrition* 57(3), 434-440.

La Vecchia, C., Nutriz, S.E., Fernandez, E. and Decarli, A. (1997) Diet diversity and gastric cancer. *International Journal of Cancer* 72(2), 255-257.

Melina, V., Craig, W. and Levin, S. (2016) Position of the Academy of Nutrition and Dietetics: vegetarian diets. *Journal of the Academy of Nutrition and Dietetics* 116(12), 1970-1980.

Merrigan, K., Griffin, T., Wide, P., Robben, K., Godberg, J. and Dietz, W. (2015) Designing a sustainable diet. *Science* 350(6257), 165-166.

Michels, K.B. and Wolk, A. (2002) A prospective study of variety of healthy foods and mortality in women. *International Journal of Epidemiology* 31(4), 847-854.

Millen, B.E., Abrams, S., Adams-Campbell, L., Anderson, C.A., Brenna, J.T., et al. (2016) The 2015 Dietary Guidelines Advisory Committee Scientific Report: Development and Major Conclusions. *Advances in Nutrition* 7(3), 438-444.

Ministry of Health of Brazil (2015) Dietary guidelines for the Brazilian population 2014. Available at http://bvsms.saude.gov.br/bvs/publicacoes/dietary_guidelines_brazilian_population (accessed 11 March 2018).

Montagna, C., Sant'apola, L., Iavarone, F., Strangio, F., Caldera, A.R., et al. (2017) North and South American countries food-based dietary guidelines: A comparison. *Nutrition* 42, 51-63.

Montero, C.A., Levy, R.B., Claro, R.M., de Castro, I.R.R. and Cannon, G. (2010) Increasing consumption of ultra-processed foods and their impact on human health: evidence from Brazil. *Public Health Nutrition* 14(1), 5-13.

NHMRC (2013) Australian dietary guidelines. Available at https://www.eatforhealth.gov.au/sites/default/files/commen5_austindian_dietary_guidelines.pdf (accessed 5 March 2018).

ONBill, D.W., Fleming, A.L., Lamb, W.F. and Stanhope, J.K. (2018) A good life for all within planetary boundaries. *Nature Sustainability* 1, 89-95. DOI: 10.1038/s41893-018-0021-4.

Pan, A., Sun, Q., Bernstein, A.M., Schute, M.B., Mains, J.E., et al. (2012) Red meat consumption and mortality: results from 2 prospective cohort studies. *Archives of Internal Medicine* 172(7), 555-563.

Perglioni, M., Messel, G., Ferrati, G., Barre, T., Veux, F., et al. (2016) How low can dairy greenhouse gas emissions be reduced without impacting nutritional adequacy, affordability and acceptability of the diet? A modeling study to guide sustainable food choices. *Public Health Nutrition* 19(14), 2692-2674. DOI: 10.1017/S136898016000653

Pimentel, D. and Pimentel, M. (2003) Sustainability of meat-based and plant-based diets and the environment. *The American Journal of Clinical Nutrition* 78, 660-663.

Public Health England (2016) Eatwell guide. Available at <https://www.gov.uk/government/publications/the-eatwell-guide> (accessed 15 February 2018).

Qatar Ministry of Public Health (2015) Qatar Dietary Guidelines. Available at <http://services.moph.gov.qa/qdportal/home.jsp?lang=en> (accessed 3 March 2018).

Richards, E. (1904) *First Lessons in Food and Diet*. Whitcomb and Tomes, Boston, Massachusetts, USA. Available at <https://archive.org/stream/firstlessonsind00rich/page/n3/mode/2up> (accessed 12 Feb 2018).

Ripple, W., Smith, P., Haber, H.L., Montzka, S., McAlpine, C., Boucher, D. (2014) Ruminants, climate change and climate policy. Available at http://www.health.gov/dietaryguidelines/gpa2015/comments/updates/CI0230_Ripple_2014_NatureClimateChange-Ruminants.pdf (accessed 12 April 2015).

FNE (2013) The sustainable shopping basket: a guide to better shopping. Available at <https://www.bundesregierung.de/Content/DE/Pressemitteilungen/Selbstverbraucher/Naechstalltag/Anlagen/shopping-basket.pdf?blob=publicationFile&x=1> (accessed 11 March 2018).

Ruhl, L.F., Gali, R., Parise, C.A., Marro, M., Principato, L. and Vannuzzi, E. (2015) Working Toward Healthy and Sustainable Diets: The Double Pyramid Model Developed by the Barilla Center for Food and Nutrition to Raise Awareness about the Environmental and Nutritional Impact of Foods. *Frontiers in Nutrition* 2, 9. DOI: 10.3389/fnut.2015.00009

Sarubogni, P., Appleby, P.N., Muddock, A., Briggs, A.D.M., Travis, R.C., et al. (2014) Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK. *Climatic Change* 125(2), 179-192. DOI: 10.1007/s10584-014-1169-1

Sheeran, M.C., Burke, T.A., Navas-Arcen, A., Breyer, P.N., McGready, J. and Fox, M.A. (2014) Global meth- yleneurea exposure from seafood consumption and risk of developmental neurotoxicity: a systematic review. *Bulletin of the World Health Organization* 92, 254-269F.

Steyn, N., Nel, J., Nantel, G., Kennedy, G. and Labadarios, D. (2006) Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutrition* 9(5), 644-650

Swedish National Food Agency (Livsmedelsverket) (2015) Find your way to eat greener, not too much and to be active! Available at <https://www.livsmedelsverket.se/en> (accessed 24 March 2018).

The Guardian (2016) China's plan to cut meat consumption by 50%, cheered by climate campaigners. Available at <https://www.theguardian.com/world/2016/jun/20/china-has-meat-consumption-climate-change> (accessed 15 February 2018).

Taman, D. and Clark, M. (2014) Global diets link environmental sustainability and human health. *Nature* 515(7528), 518.

Toledo, A. and Burlingame, B. (2006) Biodiversity and nutrition: a common path toward global food security and sustainable development. *Journal of Food Composition and Analysis* 19(6-7), 477-483.

USDA (2015a) Dietary guidelines for Americans 2015-2020, 9th Edition. Available at <https://health.gov/dietaryguidelines/2015/guidelines/> (accessed 23 March 2018).

USDA (2015b) Scientific report of the 2015 Dietary Guidelines Advisory Committee. Available at https://ods.od.nih.gov/pubs/2015_DGAC_Scientific_Report.pdf (accessed 28 June 2018).

USDA (2016) 2015 Dietary Guidelines: Giving You the Tools You Need to Make Healthy Choices. Media release. Available at <https://www.usda.gov/medialib/2015/10/16/2015-dietary-guidelines-giving-you-tools-you-need-make-healthy-choices> (accessed 28 June 2018).

US Food Administration (1917) Food - don't waste it. Available at <https://www.fda.gov/oc/2006/09/356/> (accessed 3 July 2018).

Vandeweyer, S., De Vriese, S., Huybrechts, I., Moreau, M. and Van Oyen, H. (2010) Overall and within-food group diversity are associated with dietary quality in Belgium. *Public Health Nutrition* 13(12), 1965-1973.

WHO (1989) Preparation and use of food-based dietary guidelines. Technical Report Series 880. World Health Organization. Geneva. Available at <http://apps.who.int/iris/handle/10665/42051>

WHO_TFS_880.pdf?jsessionid=0A3827EBE7EE0323FC0BA94E18BC53B?sequence=1 (accessed 28 June 2018).

Zelboer-Sagi, S., Ivanovsky-Wagman, D., Fliess Isakov, N., Webb, M., Orenstein, D., et al. (2018) High red and processed meat consumption is associated with non-alcoholic fatty liver disease and insulin resistance. *Journal of Hepatology* 68(6), 1239-1246. DOI: 10.1016/j.jhep.2018.01.015

Appendix E: Ethics Report – Low Risk Letter

Date: 12 May 2018

Dear Rebekah Jones

Re: Ethics Notification - 4000019495 - Multi-sectoral opinion of the introduction of sustainability

guidelines into New Zealand's food-based dietary guidelines, the 'Eating and Activity guidelines for New Zealand Adults': an exploratory study.

Thank you for your notification which you have assessed as Low Risk.

Your project has been recorded in our system which is reported in the Annual Report of the Massey University Human Ethics Committee.

The low risk notification for this project is valid for a maximum of three years.

If situations subsequently occur which cause you to reconsider your ethical analysis, please contact a Research Ethics Administrator.

Please note that travel undertaken by students must be approved by the supervisor and the relevant Pro Vice-Chancellor and be in accordance with the Policy and Procedures for Course-Related Student Travel Overseas. In addition, the supervisor must advise the University's Insurance Officer.

A reminder to include the following statement on all public documents:

"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Associate Professor Tracy Riley, Acting Director - Ethics, telephone 06 3569099 ext 84408, email humanethics@massey.ac.nz. "

Please note, if a sponsoring organisation, funding authority or a journal in which you wish to publish requires evidence of committee approval (with an approval number), you will have to complete the application form again, answering "yes" to the publication question to provide more information for one of the University's Human Ethics Committees. You should also note that such an approval can only be provided prior to the commencement of the research.

Yours sincerely

Research Ethics Office, Research and Enterprise

Massey University, Private Bag 11 222, Palmerston North, 4442, New Zealand T 06 350 5573; 06 350 5575 F 06 355 7973

E humanethics@massey.ac.nz W <http://humanethics.massey.ac.nz>

