Assessing the Sustainability of Indigenous Food Systems in Pacific Small Island Developing States (PSIDS)

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Abstract

Indigenous Peoples living in Pacific Small Island Developing States (PSIDS) who have traditionally relied on locally grown, biodiverse foods for their primary source of nutrition are now seeing the adverse impacts of changing diets and climate change. Shifts away from traditional diets towards modern, imported and ultra-processed foods are likely giving rise to noncommunicable diseases such as cardiovascular disease and Type 2 Diabetes Mellitus, which are now the leading causes of mortality. Climate change is magnifying health inequities and challenging food and nutrition security through heavier rains, longer droughts, and rising sea levels. COVID-19 has highlighted additional challenges for those living in PSIDS, exposing vulnerabilities across global food systems. Using Solomon Islands as a proxy for the broader Pacific, this thesis aims to assess PSIDS food system sustainability, including diet quality and diversity, as well as perceived food system transitions. Findings from this thesis can help strengthen discourse around promoting sustainable and resilient food systems and help achieve food and nutrition security targets set by the United Nations Sustainable Development Goals (SDGs).

Preface

Tēnā koutou,

There are countless individuals who deserve recognition for their support and guidance throughout the development of this thesis.

I wish to thank my supervisors for their guidance and encouragement over the past three years: Prof Jane Coad, and Prof Carol Wham, and Prof Barbara Burlingame. I would also like to thank Dr. Sunia Foliaki for his support. I would like to thank my parents for supporting my decision to move to the other side of the world to pursue my Ph.D. at Massey University.

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Lastly, and most importantly, I am humbled to have been able to work with Indigenous Solomon Islanders. Without their participation this research would have not been possible.

Tēnā rawa atu koe

“If the land is well and the sea is well,
the people will thrive”

- Māori Proverb

Indigenous Pacific Islanders of Aotearoa, New Zealand

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Vogliano, C., Murray, L., Coad, J., Wham, C., Maelaua, J., Kafa, R., & Burlingame, B. (2021). Progress towards SDG 2: Zero hunger in Melanesia – A state of data scoping review. *Global Food Security*, *29*, 100519.

CHAPTER 3

FAO and Alliance of Bioversity International and CIAT. 2021. *Indigenous Peoples' food systems: Insights on sustainability and resilience from the front line of climate change*. Chapter 4: From the ocean to the mountains: storytelling in the Pacific Islands. Rome.

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Vogliano, C., Raneri, J. E., Coad, J., Tutua, S., Wham, C., Lachat, C., & Burlingame, B. (2021). Dietary agrobiodiversity for improved nutrition and health outcomes within a transitioning Indigenous Solomon Island food system. *Food Security*, 1-29.

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Vogliano, C., Raneri, J. E., Maelaua, J., Coad, J., Wham, C., & Burlingame, B. (2021). Assessing Diet Quality of Indigenous Food Systems in Three Geographically Distinct Solomon Islands Sites (Melanesia, Pacific Islands). Nutrients, 13(1), 30.

APPENDIX A

Haynes, E., Brown, C. R., Wou, C., **Vogliano, C**., Guell, C., Unwin, N. (2018). Health and other impacts of community food production in Small Island Developing States: a systematic scoping review. *Revista panamericana de salud publica* (*Pan American Journal of Public Health)*, 42, e176.

APPENDIX B

Jones, R., **Vogliano, C.,** Burlingame, B. (2018). Sustainable Diets and Food-based Dietary Guidelines. In Sustainable Diets: Linking Nutrition and Food Systems (Eds. Burlingame & Dernini). *Centre for Agriculture and Bioscience International (CABI)*, Oxfordshire, UK.

APPENDIX C

Vogliano, C., Wham, C., Coad, J., & Burlingame, B. (2019). Can Leveraging Agrobiodiverse Food Systems Help Reverse the Rise of Malnutrition in Pacific Small Island Developing States (PSIDS)?. Multidisciplinary Digital Publishing Institute Proceedings, 37(1), 18.

APPENDIX H

Burlingame, B., **Vogliano, C**., & Eme, P. E. (2019). Leveraging agricultural biodiversity for sustainable diets, highlighting Pacific Small Island Developing States. In Advances in Food Security and Sustainability (Vol. 4, pp. 133-173). Elsevier.

Conference Presentations (2017-2020)

Today's Dietitian Virtual Symposium May 2020
Sustainable Food Systems Master Class, Virtual (600+ attendees)

Nutrition Society of New Zealand Nov 2019
Presented Ph.D. research findings (won best student presentation award), Napier NZ

IMMANA and LCIRAH Agriculture Nutrition and Health (ANH) Academy Week Jun 2019
Leveraging agrobiodiverse food systems in PSIDS, Hyderabad India

Zespri (Kiwifruit) International May 2019
Nutrition and Health Trends across New Zealand, Tauranga, New Zealand (~30 attendees)

IUHPE World Conference on Health Promotion Apr 2019
Biodiverse food systems in Pacific countries, Rotorua NZ (~45 attendees)

Feeding the Future SDGs 2 + 12 Nov 2018
Faculty Seminar Panellist, Massey University (~30 attendees)

Food and Agriculture Organization (FAO) Nov 2018
Expert Symposium on Indigenous Food Systems, Panellist, UN FAO, Rome Italy (~180 attendees)

Food Evolution Webinar with Today's Dietitian Sept 2018
GMOs and the Future of Food with Trace Sheehan (~3,200 attendees)

Promoting Sustainable Diets in Practice Feb 2018
National Dietetic Symposium, Davao City, Philippines (~1100 attendees)

Chapter 1: Introduction and Aims

1.1 Introduction

Sustainable diets are essential components towards achieving the goals outlined by the United Nations Sustainable Development Goals (SDGs). Diets must meet four primary dimensions to be considered truly sustainable: sociocultural, economic, nutritional, and environmental. This thesis aims to assess the sustainability of diets in Pacific Small Island Developing States (PSIDS) with a special focus on Melanesian countries, and using indigenous Solomon Island food systems research as a proxy for the broader Pacific.

Sustainable diets are defined by the UN FAO as 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"(Burlingame & Dernini, 2012). Sustainable diets also include Indigenous food systems and associated knowledge (Kuhnlein et al., 2018).

The term "food system" encompasses a vast array of relationships connecting environmental, social, health, political, agriculture, economic, and biological systems (Tendall et al., 2015). Farmers grow crops based on consumer demand and market prices. Consumer demand is influenced by policy, advertising, access, culture, and education. All choices have impacts on and trade-offs with human and planetary systems, including land, soil, water, and ecological biodiversity (Willett et al., 2019).

On September 25, 2015, the United Nations General Assembly, along with countries from around the world, designed 17 cross-cutting goals to serve as a blueprint to achieve a better and more sustainable future for all (United Nations, 2015). These 17 goals, known as the Sustainable Development Goals (SDGs), aim to address global challenges including poverty, inequality, climate, environmental degradation, peace, and justice. Four SDGs specifically guide the blueprint for this research; Zero Hunger (#2), Responsible Consumption and Production (#12), Climate Action (#13), and Life on Land (#15). Ban Ki-moon, the previous Secretary-General of the United Nations, opened World Food Day in October 2015, making clear the stark linkages between agriculture and climate change, highlighting the necessity for change if we aim to achieve a food secure future:

> We highlight the close link between climate change, sustainable agriculture and food and nutrition security with the message that "The climate is changing. Food and agriculture must too." Without concerted action, millions more people could fall into poverty and hunger, threatening to reverse hard-won gains and placing in jeopardy our ability to achieve the Sustainable Development Goals.

As agricultural yields have increased over the past four decades, so has the reliance on agrichemical inputs, leading to widespread environmental degradation (Dowdall & Klotz, 2016). Globally, the Green Revolution helped produced more yields, much more cheaply. However these production methods have also coincided with a rise in the triple burden of malnutrition: malnutrition, overnutrition, and undernutrition (Gómez et al., 2013).

Industrialized food systems prioritize profit over health (Stuckler & Nestle, 2012), giving rise to the increased prevalence of ultra-processed foods in global diets. Ultra-processed foods are typically energy dense; have a high glycemic load; are low in dietary fiber, micronutrients, and phytochemicals; and are high in unhealthy types of dietary fat, free sugars, and sodium (Monteiro et al., 2019). Popkin (2017) has said that "the modern diet must change, and with it our food system, if the human population is to reduce global emissions, cut water use, and enact many other agriculture-related changes that will foster a more sustainable food supply and a healthier population."

Climate change and the future of nutrition

Food systems (including production, transportation, and waste) are leading sources of greenhouse gas emissions, thus accelerating climate change (Vermeulen et al., 2012). In turn, climate change is also impacting the productivity and nutrient quality of food systems, with a particular stress on subsistence agricultural producers (Morton, 2007). Researchers have modelled the impact of rising atmospheric carbon dioxide (CO_2) levels on staple crops and found significant decreases in essential nutrients. Rice, a crop that feeds more than 2 billion people globally, is projected to experience major losses in nutrients over the next three decades, including protein, micronutrients, and vitamins (Zhu et al., 2018). Populations that rely on nutrients from a small number of plants — commonly peoples of lower socioeconomic status (SES) — will experience proportional adverse impacts of these nutrient losses, aggravating existing and encouraging new cases of malnutrition. For example, nearly 600 million people, primarily in Southeast Asia, obtain more than 50% of their daily energy from rice alone. If we aim to achieve the United Nations SDGs, future food systems must encourage dietary diversity, sustainability, and nutrition security for all (Ruel, 2003).

Biodiversity within food systems

Global biodiversity is declining at alarming rates, and food systems are a leading driver (Springmann et al., 2018). Biodiversity is defined as the variability among living organisms from all sources, including diversity within species, between species, and of ecosystems (World Health Organization, 2015). This new manmade phase of biodiversity loss has been named the Anthropocene period and is cited as one of the world's most concerning challenges (Smith & Zeder, 2013). Ecologists found that the loss of biodiversity would negatively influence human access to reliable food, clean water, and raw materials. This loss is predicted to disproportionally impact the poor and most vulnerable (Sandifer et al., 2015).

Agricultural biodiversity, or agrobiodiversity, is also declining rapidly (Campbell et al., 2017). Since the end of the twentieth century, nearly 75 percent of genetic diversity among plants has been lost in favor of genetically uniform, high-yielding varieties. Globally today, only 12 species of plants and 5 species of animals make up 75% of the world's food (United Nations System Standing Committee on Nutrition, 2018). These few species are processed into a variety of formats, giving consumers the illusion of diversity. What's more, this consolidation of species has created a food system that is focused on producing large amounts of inexpensive, low-quality foods, and has encouraged the rise of noncommunicable diseases (NCDs) (Monteiro et al., 2013).

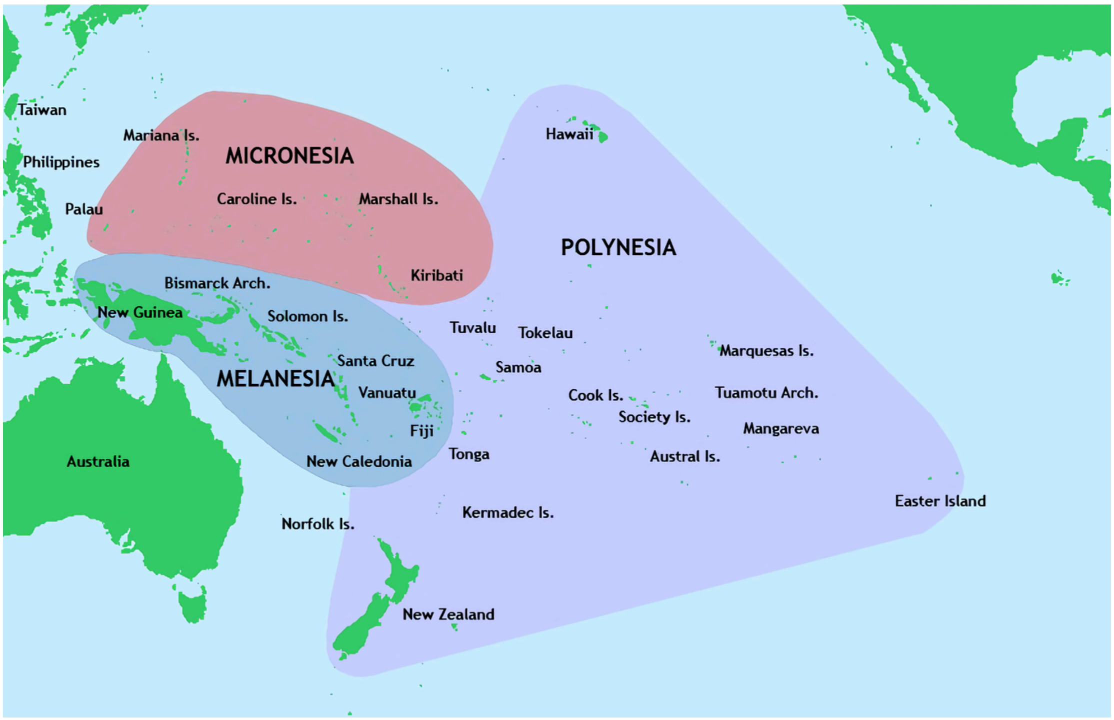
Agrobiodiversity contributes vitally to sustainable food systems and to the interconnected Sustainable Development Goals and Aichi Biodiversity Targets (Remans & Smukler, 2013; Thrupp, 2000). The Convention on Biological Diversity (CBD) has developed a Strategic Plan for Biodiversity 2011–2020, including the biodiversity-specific Aichi Biodiversity Targets, which has helped to set up a global framework to align with and help achieve biodiversity-related Sustainable Development Goal targets. Conservation and sustainable use of biodiverse and sustainable agriculture can prevent and lift people out of poverty by increasing their incomes and reducing vulnerability to external economic or environmental disasters (Convention on Biological Diversity, 2016).

Increased production diversity (on farms) has been linked with improved dietary diversity outcomes, but more research is needed, particularly in PSIDS (Jones, 2017). UN FAO has developed guidelines to assess biodiversity within dietary intakes assessments, such as 24-hour dietary recalls (Kennedy et al., 2017). Reporting at the species level can also help assess the contribution of wild collected foods, neglected and underutilized species (NUS), and self-cultivated foods. Balanced and diverse diets are correlated with a higher likelihood of achieving food and nutrition security (Ruel, 2003; United Nations System Standing Committee on Nutrition, 2018). However, depending on the population and context, increased dietary diversity alone may not lead to lower rates of obesity (Salehi-Abargouei et al., 2016). It is well supported that scaling agrobiodiversity within food systems is necessary to achieve the UN SDGs, and is at the center of achieving food security, improved nutrition, adaptation to climate change, and conservation of genetic diversity and associated traditional knowledge (World Health Organization, 2015). Leveraging plant and animal genetic diversity can help increase nutrition benefits, preserve traditional knowledge, and reduce farmers' vulnerability to climate change (Burlingame & Dernini, 2012).

1.2 Pacific Small Island Developing States (PSIDS)

PSIDS are classified by three ethnogeographic regions, as shown in Figure 1.1: Micronesia, Polynesia, and Melanesia. Melanesia contains the majority of the land area (>80%), whereas Polynesia contains most of the ocean area in PSIDS. Thousands of distinct languages and cultures exist across PSIDS. PSIDS are experiencing a rapid rise in previously unexperienced NCDs, challenging the health care systems and budgets of these low-resource island nations (Hawley & McGarvey, 2015). PSIDS, and particularly Melanesian ecosystems and agroecological zones, are among the most biodiverse regions of the world (Burlingame et al., 2019).

Figure 1.1 Ethnogeographic regions of Oceania



Source: https://commons.wikimedia.org/wiki/File:Pacific_Culture_Areas.png

Indigenous Food Systems in Pacific Small Island Developing States (PSIDS)

Traditionally, Indigenous food systems are sourced from cultivated and wild crops and are closely adapted to local conditions. They include a high level of biological diversity, have a light carbon footprint, and rely on working within the confines of native ecosystems to produce food (FAO, 2017a). Indigenous peoples are guardians of biodiversity knowledge, and their contributions should be included in the global goals for sustainable food systems and planetary health. These changes rest behind impending climate changes, which are predicted to challenge accumulated traditional knowledge through changes in landscapes and weather patterns and rising sea levels (Turner et al., 2013).

Climate Change in PSIDS

PSIDS contribute minimal quantities of global greenhouse gas emissions, yet disproportionally experience adverse impacts from climate changes (Allen, 2015). Rising sea levels, ocean acidification, and increasingly extreme weather patterns are threatening PSIDS and their food and nutrition security (Convention on Biological Diversity, 2016). A more detailed report of Indigenous Solomon Islanders' experiences with climate change appears in Chapter 4.

The Nutrition Transition in PSIDS

Food systems are complex socio-ecological systems operating at multiple scales. Data for many PSIDS are limited, but available literature suggests that a nutrition transition is taking place throughout in Oceania (Hughes & Lawrence, 2005). Indigenous Pacific Islanders who have traditionally relied on locally grown traditional foods for their primary sources of food and nutrition are now experiencing adverse impacts of transition diet patterns. Previously rare conditions, such as cardiovascular disease and Type 2 diabetes mellitus (T2DM), are now the leading causes of mortality across the country (World Health Organization, 2014).

Colonialism and the Westernization of lifestyles have introduced imported foods previously not found in PSIDS. Imported foods tend to be energy-dense and nutrient-poor (Campbell, 2015). Since World War II, traditional foods have been replaced with diets high in meat, processed foods, sugar, and refined carbohydrates (Chapter 5). Specific imports from the United States and New Zealand, such as turkey tails and lamb and mutton, are key contributors to saturated fat intakes in certain Pacific Islands (Gewertz & Errington, 2010). Several countries, including Fiji, Samoa, and Tonga, have cited health concerns in their attempts to enact legislation limiting the import of these highly processed but were met with international resistance citing trade violations (Thow & Snowdon, 2010).

Given the isolation of PSIDS, the consumable foods that reach their shores tend to be less perishable, such as packaged or canned foods. Import trends from Fiji indicate a rise in certain healthy foods, but most significantly show increases in less healthy foods from 1980 to 2013, including a 1130% increase in edible oils and spreads, a 1900% increase in fatty meat products, a 3905% increase in energy-dense beverages, and a 4765% increase in white rice (Ravuvu et al., 2018). Imported perishable foods from neighboring countries tend to be more expensive than locally produced foods, meaning that these foods are out of reach for most subsistence farmers.

However, when discussing nutrition transitions, it is important to recognize that trade-offs exist. Dietary shifts are influenced by sociocultural changes in food preference towards those that are more convenient, less expensive, and easier to prepare (Lebot & Siméoni, 2015). This is particularly true for urban areas where households, unlike those in rural areas, may not have the land or time to devote to cultivating agri-food products.

Traditional Knowledge Loss

Traditional knowledge across PSIDS is diverse and rich (Chand Savin et al., 2014). However, with nutrition transitions also comes the loss of this knowledge. Oral traditional knowledge of Indigenous food systems often erodes more quickly than the foods themselves (Lwoga et al., 2010). This trend may stem from the fact that urbanizing Indigenous communities increasingly consider local foods and traditional knowledge to be of low value (Dweba et al., 2011). For example, Indigenous communities often value imported fruits and vegetables more highly than traditional varieties. Nonetheless, local foods are an important source of many essential micronutrients in PSIDS (Konishi et al., 2011).

Focusing on Melanesia

Melanesian countries include Papua New Guinea, Solomon Islands, Fiji, Vanuatu and the French territory of New Caledonia. Melanesia contains most native and endemic Pacific biodiversity, with Papua New Guinea hosting the largest array of unique biodiversity (Aalbersberg et al., 2012). Papua New Guinea also hosts over 800 distinct languages, out of ~6,500 globally (Codrington, 1885), though they are disappearing rapidly. Of all the Melanesian countries, Fiji and the French territory of New Caledonia are considered the most economically advanced due to higher tourism rates. In New Caledonia, there is a large class divide between the Indigenous peoples and resident French population.

Population Projections

Most Melanesian peoples live in rural villages. However, rapid urbanization is underway as villagers seek enhanced economic opportunities and mobility (Posso & Clarke, 2016). Melanesian countries are projected to have significant rises in population by 2050 (Table 1.1). The total population of Melanesia, currently 11.1 million in 2020, is expected to rise to 17.4 million by 2050. Population growth is most notable in Papua New Guinea (2.9% growth rate annually), Solomon Islands (2.5%), and Vanuatu (2.4%) (United Nations, 2019). Increased populations will magnify the use of land and natural resources, which can increase pressures on local food systems and amplify malnutrition.

Table 1.1: Overview of Melanesian populations, land area, and GDP*

Country or Territory	Population	Growth rate (2020)	Projected 2050 population	Area (km²)	GDP (per capita, $USD)
Papua New Guinea	12,982,755	2.85%	14,204,000	245,857	$1,038
Fiji	893,810	0.73%	1,071, 000	18,272	$6,326
Solomon Islands	679,599	2.57%	1,290,000	28,896	$2,339
Vanuatu	304,045	2.44%	557,000	12,189	$3,236
New Caledonia	284,413	0.98%	346,000	18,575	$33,085
Melanesia (total)	15,144,622	1.87%	17,469,000	8,525,989	$3,764

* UN (2019)

1.3 Solomon Islands

Geography and demographics

Solomon Islands is comprised of over 900 islands containing vast cultural and ecological knowledge. Over three-quarters of the over 600,000 present-day Solomon Islanders live in rural Indigenous villages, and 89% still rely on subsistence agriculture for most of their nutrition and energy (SINSO, 2017). Solomon Islands is home to over 75 distinct languages, which formed on the 900-some islands making up the country (Rumsey, 2019). Many Indigenous Solomon Islanders have minimal connection to their national government in Honiara on Guadalcanal Island, given their remoteness and self-sufficiency. However, due to climate changes and rises in NCDs, evidence suggests that these communities increasingly rely on governmental and international aid (Dornan & Pryke, 2017).

Biodiversity in Solomon Islands

Melanesian ecosystems and agroecological zones are among the most diverse in the world (Burlingame et al., 2019). Solomon Islands is recognized as a "Centre of Plant Diversity" and is home to 4,500 different species of plants, 3,200 of which are native and at least 120 of which are edible (Convention on Biological Diversity, 2016). With thousands of endemic species, preserving biodiversity is a main goal of the Solomon Islands government, because it is important for the economy, cultural preservation, and tourism (Convention on Biological Diversity, 2016).

Solomon Islands is home to diverse Indigenous food systems, which have played an integral role in supporting livelihoods and well-being. Solomon Islands' biodiversity status is still in decent health due to low population density, uninhabited islands, customary land use, and barriers to accessibility (Convention on Biological Diversity, 2016). However, island agrobiodiversity is rapidly being degraded and even lost due to increasing monocultures, land pressures, deforestation, and urbanization (Thaman, 2008).

Health of Solomon Islanders

Biodiversity is well known to support food and nutrition security (Hunter & Fanzo, 2013). However, Solomon Islanders suffer from under-, over-, and micronutrient deficiencies, or the triple burden of malnutrition. The prevalence of undernourishment was steadily declining between 2001 and 2011, but the percentage of undernourishment has started to rise again and now sits at around 14% of the population (FAOSTAT, 2018). Using country-level data sourced from the FAO's food balance sheets, Solomon Islands was determined to have deficits in vitamin A, vitamin B_2, calcium, iron, and zinc (Rosalind & Cavalli-Sforza, 2012). Currently, 93.1% of Solomon Islanders consume fewer than five servings of fruits and vegetables daily, and 52.2% of adults living in Solomon Islands are overweight or obese (Solomon Islands National Statistical Office, 2017). Anthropometric measures (n= 3,247 women and 1,693 men >15 years of age) were collected in three provinces (Guadalcanal, Malaita, and Western), with the finding that 29.9% of women and 25.0% of men were overweight and that 14.5% of women and 5.8 % of men were obese. Only 1.9 percent of women and 2.2 percent of men were underweight, suggesting that they are affected by "hidden hunger" — deficiencies in essential vitamins and minerals, leading to reduced growth, impaired development, and decreased ability to fight infection (Solomon Islands National Statistical Office, 2017).

However, it has been argued that BMI cut points should be reclassified for PSIDS to accommodate regionally specific body composition differences (Eme et al., 2020). Rises in NCDs among Solomon Islanders, and Pacific Islanders as a whole, are placing excess stress on these countries' already underfunded health care systems.

1.4 International and Regional Food System Frameworks and Policies

International policies and frameworks for PSIDS

There are numerous international and regional policies and frameworks aimed at improving health outcomes. Of these, the most notable framework related to the improvement of health and nutrition are the United Nations Sustainable Development Goals (SDGs). The SDGs comprise 17 cross-cutting goals, including various human and planetary health targets, particularly, those in relation to agricultural production and consumption. Specifically, SDG 2 is focused on achieving zero hunger through healthy, equitable, and sustainable food systems.

Aligned with the SDGs' global goals is the Convention on Biological Diversity's (CBD) Strategic Plan for Biodiversity, which includes the Aichi Targets titled, "Living in Harmony with Nature" (Marques et al., 2014).

The five foundational **Aichi Biodiversity Targets (Convention on Biological Diversity, 2020a) are:**

1) **Strategic Goal A**: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.
2) **Strategic Goal B:** Reduce the direct pressures on biodiversity and promote sustainable use.
3) **Strategic Goal C:** Improve the status of biodiversity by safeguarding ecosystems, species, and genetic diversity.
4) **Strategic Goal D:** Enhance the benefits to all from biodiversity and ecosystem services.
5) **Strategic Goal E:** Enhance implementation through participatory planning, knowledge management and capacity building.

These are all linked to CBD's goal that "by 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy planet and delivering benefits essential for all people" (Marques et al., 2014).

Notedly, activists and scientists have continually advocated for increased coordination of efforts that address the multiple forms of malnutrition and ensure that food systems are just, equitable, and sustainable (Micha et al., 2020). In relation to the need for increased coordination efforts, in 2021, the UN Secretary-General, António Guterres announced plans to convene a global Food Systems Summit as part of the Decade of Action to achieve the Sustainable Development Goals (SDGs) by 2030 (United Nations, 2020). This summit aimed to convene and unite key food system actors, including farmers, academics, the private sector, governments, Indigenous Peoples, youth, environmentalists, and other key stakeholders with the aim of building more sustainable and resilient foods systems (United Nations, 2020). Such increased international momentum and coordination aimed at improving food systems can have significant local, regional, and global impact, including impact on PSIDS.

Regional Frameworks and Policies

In September 2009, a steering group of Indigenous Peoples representing Small Island Developing States (SIDS) were convened by the World Health Organization of the Western Pacific Region to focus on Revitalizing Primary Health Care in the Pacific (World Health Organization, 2013). They reached an agreement on the need for a bottom-up approach to address health issues, and a strategy framework that can be tailored to fit each country and culture's specific needs. In 2011, the WHO convened another steering group of 12 public health experts to further affirm the vision of, the guiding principles of, and a strategy for achieving healthy islands (World Health Organization, 2012). The vision states that "The Pacific Islands would be a place where: children are nurtured in body and mind; environments invite learning and leisure; people work and age with dignity; ecological balance is a source of pride; and the ocean that sustains us is protected."

Building upon previous frameworks and recommendations, the third convention focused on supporting sustainable futures in SIDS was hosted in Apia, Samoa in 2014. This conference, which attracted global attention, highlighted the unique vulnerabilities faced by those living in SIDS. The outcomes formed the basis of the pathway known as the "SIDS Accelerated Modalities of Action," or the SAMOA Pathway (UN General Assembly, 2014). The SAMOA Pathway specifically details the need for international cooperation and partnerships to address the persistent development challenges of SIDS, a necessary measure for the attainment of internationally agreed goals such as the SDGs.

The SAMOA Pathway is consistent with the 2030 Agenda for Sustainable Development, and paragraph 60 specifically recognizes "the danger caused by an unhealthy diet and the need to promote healthy food production and consumption" (UN General Assembly, 2014). It also reaffirms, in discourses about sustainable development, SIDS' unique characteristics – SIDS are remote island nations and are more likely to experience the adverse effects of climate change, therefore, they should be given special attention. The SAMOA Pathway explicitly calls for "the further promotion of sustainable food systems and the combating of all forms of malnutrition, including undernourishment and obesity, with a view to ensuring food security, improving nutrition, and fostering healthy diets and lifestyles" (UN General Assembly, 2014). This pathway also encourages the sustainable use and conservation of biological diversity (UN General Assembly, 2014).

Following the publication of the SAMOA Pathway, the Global Action Programme on Food Security and Nutrition in Small Island Developing States, or "GAP," aimed to accelerate action towards the goals outlined in the Pathway (FAO, 2017b). The GAP is in direct response to paragraph 61 of the SAMOA Pathway, and is intended to serve as a tangible implementation strategy for addressing food and nutrition insecurity in SIDS. The three objectives outlined in the GAP are as follows: strengthening enabling environments for food and nutrition security through actions that increase political commitment to this; encouraging appropriate stakeholder investment in the development of more resilient and sustainable food systems, and empowering people and communities.

In September 2019, the United Nations General Assembly had a one-day high-level evaluation of the implementation of the Small Island Developing States Accelerated Modalities of Action (SAMOA Pathway, 2014) (UN General Assembly, 2019a). The resulting political declaration recognized the progress made, while also highlighting the persistent challenges faced by those living in PSIDS. The outcomes of this evaluation was a detailed list of 24 actions necessary to further advance the sustainable development of SIDS, including targeted measures to eradicate poverty; improve access to sufficient, safe, and nutritious food; enhance livelihoods; and scale up investments in science, technology, and economic growth opportunities (UN General Assembly, 2019b).

The CBD has identified strategies uniquely designed for, and accepted by, Solomon Islands which can protect, embrace, and promote biodiversity within ecosystems, as well as in agricultural production and fishing practices (Convention on Biological Diversity, 2020b). The strategies, outlined in the Aichi Biodiversity Targets, are focused on addressing the underlying causes of biodiversity loss within Solomon Islands, maintaining traditional genetic agrobiodiversity, improving the protection of land and marine-based biodiversity, and safeguarding traditional knowledge associated with biodiversity (Convention on Biological Diversity, 2020b).

Based on the foregoing, it is evident that much alignment exists among the global, regional, and local frameworks and policies that focus on building more sustainable food systems. The recommendations made by these different frameworks and policies frame the approach through which the primary research question and objectives of this thesis are addressed.

1.5 Discussion

Globally, food systems are becoming less diverse and more homogeneous. These changes are leading to increased food system vulnerabilities while encouraging the overconsumption of energy-dense and nutrient-poor foods. Additionally, food systems are the leading drivers of climate change and biodiversity losses. Hence, biodiversity conservation is fundamental to the sustenance of the ecosystems upon which human survival and well-being depend (Sandifer et al., 2015). PSIDS are uniquely vulnerable to these changes in food systems, and failure to conserve and promote agrobiodiversity will likely accelerate food insecurity, poor nutrition, and worsened health outcomes among PSIDS populations.

Indigenous knowledge and practices can offer insights into the conservation of agrobiodiversity (Convention on Biological Diversity, 2016). To understand the relationship among traditional knowledge, culture, and food as well as barriers to behavioural change, it is critical to assess the quality and diversity of diets and the knowledge, attitudes, and practices of those living in PSIDS (Cassel & Boushey, 2015). However, if the decline of traditional foods continues, as well as the knowledge surrounding these foods (most of which has been passed down for centuries), diets will likely continue to shift towards a western style dietary pattern, leading to continued rise in noncommunicable diseases (NCDs). As populations become denser and significantly younger, ensuring traditional knowledge transfer may help to make food systems remain sustainable and resilient in the face of the climate crisis and nutrition transition. However, further research is needed to examine the role of agrobiodiversity in building more resilient and sustainable food systems across PSIDS.

1.6 Gaps and Need

Currently there is sparse literature that examine local food system resilience, household diet diversity, and nutrient intake in relation to food insecurity and malnutrition in PSIDS. This thesis aims to fill this research gap by examining the diet quality of Indigenous Solomon Islanders and agrobiodiversity in Solomon Islands. This is significant because the study's findings have the potential to propose a strategy for meeting the nutritional requirements of adults and children, and to prevent malnutrition in all its forms. For example, Kenya's ethnobiological inventory of available food biodiversity was investigated using neglected and underutilized species, including wild foods, to improve dietary biodiversity and nutrition security (Termote et al., 2014). The results indicated that wild foods do and can play a significant role in mitigating malnutrition in a culturally appropriate and equitable way. There is, therefore, an urgent need for agricultural research centres, academia, and community-based organizations to work together within a shared policy framework to develop a strong evidence-based body of research linking biodiversity, nutrition, and health (Frison et al., 2006).

1.7 Problem Statement

Modern food systems are not sustainable. Although they are able to sustain life for billions of people, they are also simultaneously the leading drivers of deforestation, greenhouse gas emissions, and the proliferation of NCDs (Campbell et al., 2017; Willett et al., 2019). Food systems, both modern and traditional, are also deeply interconnected with global poverty, in that 2.6 billion people are estimated to derive their primary livelihoods from food production as subsistence farmers (International Labour Organization, 2015). It is projected that climate change, increase in population, and finite natural resources (such as water, soil fertilizers, and soil quality) will magnify current health, environmental, and social inequities. Therefore, there is an urgent need to propose solutions to improve the sustainability of food systems.

Specifically, PSIDS are currently experiencing a global syndemic – the simultaneous threat of overnutrition, undernutrition, and climate change (Swinburn et al., 2019). Indigenous Pacific Islanders have traditionally relied on locally grown, biodiverse foods to supply and meet their nutritional needs, as evidenced by research from the past decades which highlight the healthiness of Indigenous peoples' local diet (Damon, 1974; Page et al., 1974). However, recent data show that PSIDS are undergoing nutrition transitions, leading to increased rates of NCDs (Cassels, 2006; Malik et al., 2013; Popkin, 2001). In fact, nine of the ten countries with the highest rates of obesity in the world are in PSIDS (Hughes, R. G., & Lawrence, M., 2005). In addition, once rare diseases, such as cardiovascular disease and Type 2 diabetes mellitus (T2DM), are now the leading causes of mortality across the Pacific. Further amplification of health inequities are expected due to climate change, population growth, and increased land pressures. Despite these, there are insufficient data available to help researchers understand the differences among PSIDS food systems (considering that PSIDS are culturally and geographically diverse) and how best to improve their resilience and sustainability. Therefore, the primary aim of this dissertation is to assess the sustainability of diets in Solomon Islands as a proxy for Melanesia. Therefore, the primary aim of this dissertation is to assess the sustainability of diets in Pacific Small Island Developing States, using Solomon Islands as a proxy for Melanesia.

1.8 Research question, aims, and objectives

This current Chapter (Chapter 1) provides an overview of this thesis by introducing the challenges, and associated frameworks related to food systems in PSIDS. This section (1.8) continues by defining the primary research question, approach, research aims and objectives, and significance. The subsequent section (1.9) provides a graphical flowchart of the entire thesis, including the appendices. Then, Section 1.10 provides a brief overview of the aims, methodologies, and critical reflections of Chapters 2-5.

Research Question

Are present-day Indigenous food systems in Pacific Small Island Developing States (PSIDS) sustainable?

Approach

This thesis utilized a mixed methods approach to answer the primary research question, including a comprehensive scoping review, qualitative focus group discussions, key informant interviews, and quantitative nutrition surveys. The scoping review aimed to collate published data in relating to Melanesia's progress towards achieving SDG #2: Zero Hunger, as well as background knowledge on data available in relation to the research question. Participatory qualitative focus group discussions helped characterize and assess Indigenous Peoples' food systems, knowledge, and practices. Quantitative nutrition surveys aimed to assess aspects of food system sustainability by examining agri-food production, diet quality and intakes, nutrition transitions, and health differences between rural and urban populations in Solomon Islands.

Research Aims

1. Explore the literature relating to Melanesia's progress towards Sustainable Development Goal #2 (SDG 2): Zero Hunger.

2. Assess the sustainability of present-day Indigenous food systems in Solomon Islands, Melanesia.

    2.1 Compare dietary intakes, quality, and diversity in various Solomon Island communities.

    2.2 Explore the availability and utilization of native and introduced agrobiodiversity.

2.3 Explore if and how external factors are impacting traditional food systems in Solomon Islands, Melanesia.

Research Objectives

- Synthesize recently published data (2010-2020) on the progress made towards the actualization of SDG 2: Zero Hunger in Melanesia, through a scoping review, the identification the knowledge gaps, and the proffering of recommendations.

- Characterize and assess the resilience of the Indigenous Solomon Islanders' food system in Baniata, Solomon Islands by documenting the inputs and outputs of the local food system, linkages to markets, and Indigenous practices and knowledge.

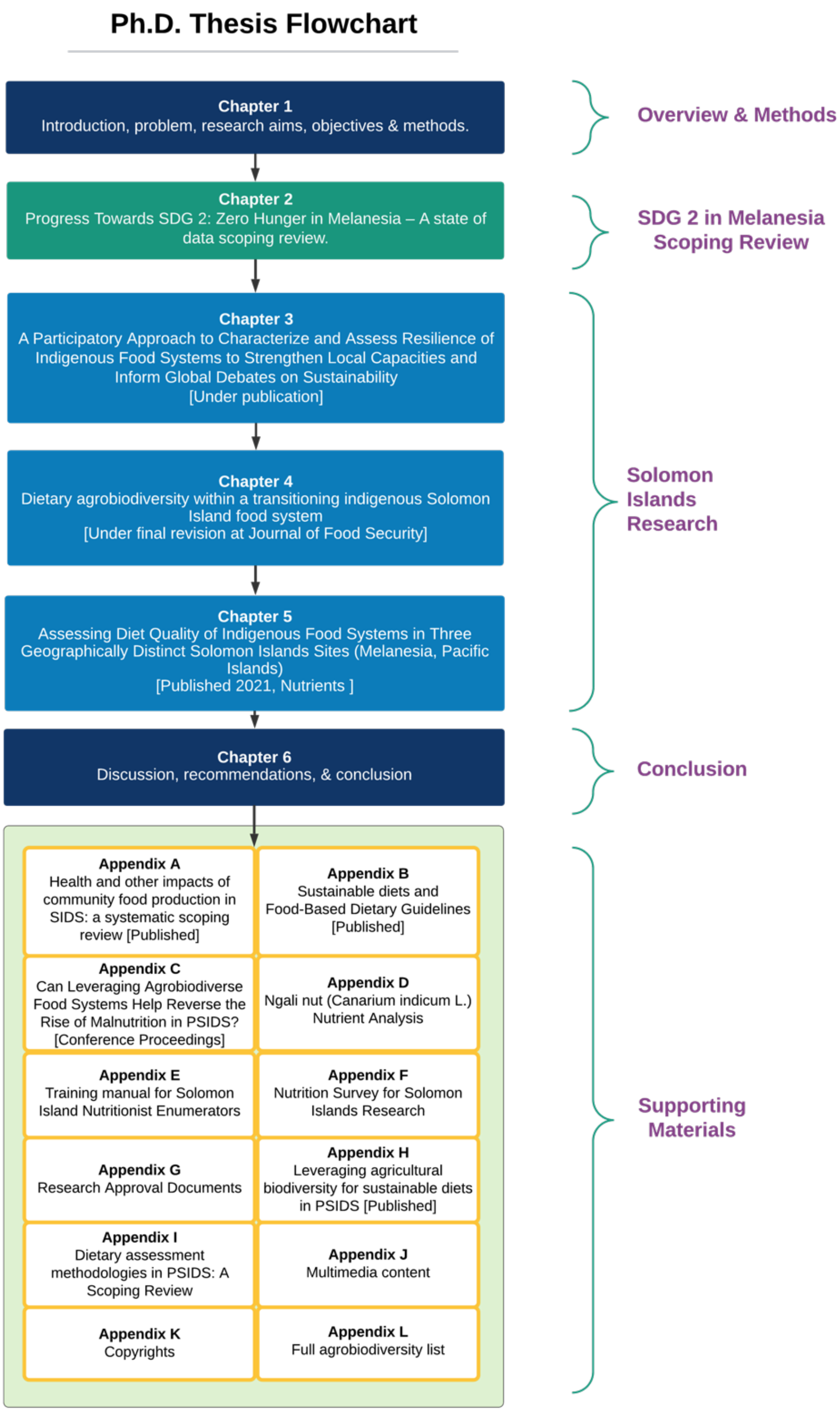
- Document available agrobiodiversity of local diets, including species and variety level information on fruits, vegetables, grains, nuts, seeds, legumes, and animal sourced foods in Western Province of Solomon Islands.

- Measure and compare food system sustainability characteristics including diet quality, sourcing of foods and ingredients consumed, and estimate annual household food security levels in select samples of geographically unique rural and urban Solomon Island populations.

Significance

Recent literature assessing diet quality and nutrition transitions in PSIDS are scarce, particularly in Melanesia. There is the need for more studies to assess the sustainability of Indigenous food systems and identify strategies for existing food systems to meet both adults and children's nutritional needs. These strategies are needed to prevent malnutrition in all its forms and realise the United Nations Sustainable Development Goals (SDGs) and the goals outlined in the SAMOA Pathway. Data from this research can help inform programming and policy interventions focused on improving diet quality and health through sustainable food systems.

1.9 Thesis Flowchart



1.10 Thesis Chapter Overview, Aims, and Methods

The four primary studies in this thesis are organized by chapter (Chapters 2-5). Each chapter provides unique insights and perspectives into the sustainability of Indigenous food systems in Melanesia and Solomon Islands.

Chapter 2 Aims and Methods

Title: Progress Towards SDG 2: Zero Hunger in Melanesia – A state of data scoping review

Aims

The scoping review in Chapter 2 was conducted using published literature from the past ten years to build a foundational understanding of Melanesia's progress in relation to the attainment of the goals outlined in SDG 2: Zero Hunger. SDG 2 and its associated targets are comprehensive, and therefore this scoping review explored numerous themes associated with zero hunger, including food and nutrition security, access to healthy diet, rates of stunting and wasting, agricultural productivity and sustainability, impacts of climate change on local food production, and agriculture-related ecosystem services.

Methods:

Chapter 2 utilized a comprehensive search strategy, with assistance from a Massey University librarian, using the SCOPUS and Web of Science databases. Search terms included "sustainable food," "agriculture," "nutrition," "hunger," "food security," "diet," "malnutrition," "biodiversity," and "agrobiodiversity." Each term was combined with geographic search terms including "Melanesia," "Fiji," "Solomon Islands," "Papua New Guinea" or "PNG," "Vanuatu," and "New Caledonia." Publications were organized, annotated, and managed using EndNote (Version X 9.3.3). Duplicate entries were removed. Titles were screened twice by different researchers for their relevancy to SDG 2 and its five associated targets. Articles were excluded if they did not feature one of the five Melanesian states, were clearly unrelated to target aims, or the full article was unable to be accessed. Further eligibility criteria excluded articles related to food processing, post-harvest losses (SDG 12), clinical or drug studies (SDG 3), infectious or tropical disease, or any topic unrelated to food and nutrition security among Indigenous Melanesians. A modified PRISMA Extension Checklist for scoping reviews was used to assess each study for appropriate participant selection and sample size (when applicable), adequate description and utilization of methodology, appropriate discussion and interpretation of findings, risk of bias based on industry-funded studies, and limitations (Tricco et al., 2018). Studies conducted outside of Melanesia were excluded. Given the broad scope of this review, data were not directly compatible and were summarized thematically into one of five of the SDG #2 targets. This scoping review was organized by the five (5) targets outlined in SDG 2: Zero Hunger. The targets (SDG 2.1 – 2.5) focus on ending hunger by ensuring access to safe, nutritious foods year-round, ending malnutrition, doubling agricultural productivity, and ensuring sustainable production systems that leverage the genetic diversity of plants and animals.

Critical Reflection:

Chapter 2 provided baseline knowledge of Melanesia's progress towards achieving SDG 2: Zero Hunger and its associated targets based on peer-reviewed literature from the past ten years. However the method used in Chapter 2 excluded white papers and government reports, which could have improved the range of data available for this scoping review. One significant finding was that participatory knowledge generation with Indigenous peoples is critical to building trust. Cultural barriers may include differences between Western science and traditional knowledge, and a lack of trust between local communities and external scientists. Underutilized and agrobiodiverse foods emerged as a possible solution for improving the resiliency and nutrient density of local food systems in Melanesia, while providing a potential to generate income for farmers and contribute to meeting SDG #2: Zero Hunger. Underutilized foods could be integrated into nutrition education, public health messaging, school nutrition programs, and public policies. Overall, Chapter 2 helped to consolidate and give structure to existing literature much more data are required to evaluate Melanesia's progress towards the realization of Sustainable Development Goal 2 (SDG 2): Zero Hunger.

Chapter 3 Aims and Methods

Title: *A Participatory Approach to Characterize and Assess the Resilience of Indigenous Food Systems to Strengthen Local Capacities and Inform Global Debates on Sustainability*

Chapter 3 utilized a rapid, participatory approach to characterize and assess the resilience of the Indigenous food system of a rural community in Solomon Islands through a series of thematic focus group discussions (FGDs).

Aim:

The primary aims of this method were to document the inputs and outputs of the local food system, linkages to markets, and traditional practices and knowledge that support resilience and sustainability of Indigenous Peoples' food systems in Baniata, Solomon Islands.

Methods:

Chapter 3's methodology and associated questions were inspired by an adapted version of the validated tool known as Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists tool (SHARP**)** (Choptiany et al., 2015). This tool and method were used to inspire a series of thematic questions, drafted by experts from Bioversity International (CIAT) and the UN FAO, with review and inputs provided by the PhD candidate. This study's methodology used participatory focus group discussions, a specific type of group interview that uses group interaction to generate data relevant to the aims of this research (Draper & Swift, 2011). The study's qualitative questions were implemented through a series of seven thematic FGDs with community representatives. Each of the seven thematic discussions concentrates on a specific aspect of the food system as described in **Table 1.2.** Thematic discussions profiled various aspects of the local food systems, including traditions and trends, natural resource use, trade, markets, climate change, governance, diet quality and diversity, and young people's perspectives. The full method guidebook for this chapter can be found in **Appendix L.**

Table 1.2. Topics and timeline for the thematic discussions

<table>
<tr><th>#</th><th>Topic</th><th>Participants</th></tr>
<tr><td>Opening meeting</td><td>Introduction to the initiative</td><td>Open invitation to full community</td></tr>
<tr><td>TD1</td><td>Traditions and trends in the food system</td><td rowspan="6"><u>Adult men:</u> ~10 men of mixed age at each FDG

<u>Adult women:</u> ~10 women of mixed age at each FGD</td></tr>
<tr><td>TD2</td><td>Sustainable natural resources use</td></tr>
<tr><td>TD3</td><td>Exchange, trade and marketing</td></tr>
<tr><td>TD4</td><td>Seasons, climate shocks and change</td></tr>
<tr><td>TD5</td><td>Food system institutions and governance</td></tr>
<tr><td>TD6</td><td>Diversity in the diet and production system</td></tr>
<tr><td>TD7</td><td>Young people's knowledge and perceptions</td><td><u>Children:</u> ~8-10 participants aged 7-12 mixed genders
<u>Youth:</u> ~8-10 participants aged 13-15 mixed genders</td></tr>
<tr><td>Closing meeting</td><td>Food system sustainability, climate change resilience, adaptation, and the future</td><td>Open invitation to full community</td></tr>
</table>

Research was categorized as low-risk research by the Massey University Human Ethics Committee prior to commencement. Research permits were received from the government of Solomon Islands, and the village elder of each community granted permission prior to commencement of research. Ethics approval and research permits appear in **Appendix G**. Prior to commencing this study, four enumerators from Solomon Islands were trained on the methods and thematic discussions during a three-day intensive workshop at Solomon Islands National University in July of 2018. Training ensured enumerators had a comprehensive understanding of the thematic discussion questions (Appendix L), and had the opportunity to modify each question (as appropriate) based on local cultural context.

Data Collection

Enumerators implemented two simultaneous focus group discussions at the same time, one for men and one for women. Each group was facilitated by two local enumerators, one facilitator and one scribe. All discussions were hosted in Pidgin, the common language that all Solomon Islanders can speak regardless of their native tongue. All focus group discussions were recorded using an audio recorder, and after each day the enumerators would review the audio files and ensure the scribe's notes were thorough and complete.

Baniata village has a population of ~900 people, of which 45 women, 29 men, and 20+ youth/children participated in the series of seven focus group discussions. The entire community was invited to an initial interactive meeting where the objectives of the initiative were presented, and the community members had the opportunity to ask questions and actively participate in the discussions. Subsequently, all community members were invited to the focus group discussions, with approximately 10 people present each day in each focus group. More women attended the discussions compared to men, and women had fewer repeat attendances compared to men. Conversely, men were more likely to participate in multiple discussions throughout the series. Participants and enumerators were provided refreshments and meals throughout each day of discussions.

Diverse community members—including elders, women, men, and youth – offered their respective inputs to the thematic discussions, as each has their own perception/associated knowledge of the food system and often have different roles and responsibilities in the system. Men and women participants participated in separate focus groups discissions to accommodate differences in perspectives and facilitate free sharing of information. Additionally, youth participated in separate focus group discussions to capture their unique perspectives about food systems and capture their future aspirations. Each discussion was captured in writing by a scribe, and by digitally via a digital audio recording.

After each day's discussions ended, the enumerators transcribed the combined audio and written notes into a digital document. Discrepancies and uncertainties were cross-checked with the elders and other villages to ensure accuracy. Upon the completion of the series of focus group discussions, a closing meeting was held with the entire community to share preliminary results on the process and outcomes.

Coding and Analysis

Following the data collection, all qualitative data were then entered into NVIVO (v.12) by the PhD candidate, and organized into specific codes and nodes, based on the method guidebook and below indicators. The coding and indicators were agreed upon collectively by the team of researchers who constructed the analysis guide, to ensure alignment with the same research being conducted in other communities. A full list of questions posed within the focus group discussion can be found in Appendix L, including qualitative and semi-quantitative queries on local dietary diversity, agrobiodiversity, and a seasonal calendar of availability.

Themes were chosen to reflect the SHARP indicators as follows:

- Socially self-organized
- Appropriately connected
- Optimally redundant
- Exposed to disturbance
- Coupled with local natural capital
- Reflective and shared learning
- Globally autonomous and locally interdependent
- Honours legacy
- Builds human capital
- Reasonably profitable

In addition to the SHARP indicators, qualitative data were categorized into five principles of sustainable food systems to align with similar research being conducted in other Indigenous communities around the world. The five principles of sustainable food systems (FAO, 2014) are:

(1) Provision of livelihoods, equity and social well-being;

(2) Resource use efficiency;

(3) Conservation, protection and enhancement of natural resources;

(4) Responsible and effective governance mechanisms;

(5) Resilience of people, communities, and ecosystems.

Written data were coded systematically to ensure equal attention was paid, and data of interest that appeared multiple times received the same coding (nodes) (Draper & Swift, 2011). In addition to the pre-determined themes, data were also coded according to various aspects of interest relating to local food systems, including geographic context, local food production (cultivated, wild collected, purchased), trade, markets, and future perspectives. A thematic style of analysis was used to identify, analyze and describe individual and group participant experiences and perspectives.

Following the coding, data were drafted by reassembling and adding context to the codes to create themes and subthemes based on the a priori themes (above) and additional themes that emerged from the initial coding of the data (Castleberry & Nolen, 2018). Data were also analyzed based on similarities and differences between the men, women, and youth FGDs. The themes and subthemes were then assembled into a structure using descriptive text, matrices, maps, and tables, forming the foundation of Chapter 3. Researchers from Bioversity International assisted in the interpretation and conclusions from the thematically coded qualitative data.

Once the final draft was ready, it was professionally edited by UN FAO consultants for publication within a free digital book of seven case studies titled *Indigenous Peoples' Food Systems: Insights on Sustainability and Resilience from the Front Line of Climate Change (FAO, 2021)*.

Critical Reflection:

Chapter 3 aimed to characterize and assess the resilience of the Indigenous food system of Baniata Solomon Islands and provide an opportunity for Solomon Islanders to voice their experiences and perspectives in relation to the transitions within their local food system. The purpose of utilizing focus group discussions was to leverage group dynamics to reveal a layer of meaning over and above what is gained during individual interviews (Draper & Swift, 2011). This was achieved in part due to the separate FGDs for women, men, and youth, and then comparing each demographic's answers during the analysis. For example, men felt traditional foods were consumed more than imported foods, and women (particularly younger women) felt traditional foods were consumed far less than imported foods, indicating that gender roles may influence perspectives regarding various aspects of the food system.

This qualitative research had many strengths, including the participatory nature of the focus group discussions and the inclusivity of a rich diversity of perspectives from a wide range of villagers. This research also excelled by using a participatory and systems-based approach to illustrate linkages between agriculture, nutrition, and food system transitions. However, it is important to note that findings from these FGDs are not statistically representative, and thus cannot be extrapolated (Fade & Swift, 2011) or overstated from a small sample size (Pilnick & Swift, 2011). There were multiple limitations to this research, including that the participant selection was based on the availability of men, women, and youth during each day's session, which may have biased the sample of participants who were able to attend, as participants had to forego many of their working hours each day that they chose to participate. This means that voices of those who were unable to attend the focus groups may not have been fully represented within the discussions and findings. Another limitation was that the coding themes were primarily a priori, meaning many of the codes were identified prior to implementation and without input from local communities, which may have limited the full perspective of the participants to be heard. Lastly, the data analysis process was likely influenced by PhD Candidate's personal biases and perspectives, which may have influenced the quality of the qualitative analysis.

Overall, chapter 3 provided a rich perspective of the past, present, and future trends experienced and expected by the villagers of Baniata in Solomon Islands, and provided insights that the local food system has shifted over the past few decades to feature more highly process foods which are contributing to increased rates of non-communicable diseases. This chapter contributes to a shared understanding of challenges, opportunities, and changes to the Indigenous food system of Baniata Village in Solomon Islands.

Chapter 4 Aims and Methods

Title: *Dietary agrobiodiversity for improved nutrition and health outcomes within a transitioning Indigenous Solomon Island food system*

Aims:

Chapter 4 aimed to build on the knowledge and information collected from Chapters 2 and 3 using a mixed-method approach to assess the relationship between dietary agrobiodiversity and health and nutrition indicators related to usual dietary intake, diet quality, and anthropometric measures of the primary female (non-pregnant or lactating) agri-food producers within 30 households in the Indigenous Solomon Island village of Baniata. Secondary aims of this study were to evaluate the contribution of agrobiodiversity from the local food system to diet quality. The secondary aims of this chapter were to evaluate the knowledge, attitudes, and practices (KAP) of the primary household cook in Solomon Islands regarding nutrition knowledge, food choices, and food waste and preservation.

Methods:

Chapter 4 used a mixed-method, observational, cross-sectional approach using nutrition surveys to assess dietary intakes, annual household food insecurity levels, anthropometrics, and knowledge, attitudes, and practices (KAP) around food and nutrition. Nutrition surveys were administered to a convenience sample of 30 women using the repeat 24-hour multiple pass recall (24hr MPR) method (Gibson et al., 2017), which was adapted to capture both the species and variety (if applicable) of each ingredient, as well as where each ingredient was sourced (i.e. market, self-cultivated, wild collected, store bought). 24hr MPRs were collected on two non-consecutive days for each participant, and used to estimate usual dietary and nutrition intakes (Harttig et al., 2011). Inclusion criteria for the nutrition surveys were women aged 15-49 who were primarily responsible for growing, gathering, and preparing food for the household (n=30). Participants were excluded if they were pregnant or lactating, as their nutrient and energy needs are different from other adults (Butte& King, 2005). If households were unable or unwilling to participate, a new household was randomly selected. In total, 30 women were surveyed, representing over one-third of village households (38%). Quantitative data were complemented by seven days' worth of participatory FGDs (Chapter 3), aimed at characterizing and assessing the resilience of Baniata's Indigenous food system, and documenting locally available agrobiodiversity.

Nutrition surveys, dietary data, and anthropometric measurements were analyzed using IBM SPSS (Version 25), Tableau Public (Version 2018.2.2), Stata (Version 14.2), and Xyris Food Works (Version 9.0.3973). Nutritional composition data and food groups were sourced from the Pacific Island Food Composition Database (Version 2) (Dignan et al., 2004) and the FAO/INFOODS databases (FAO, 2018). Local foods which could not be identified in nutrition composition data bases were substituted for comparable alternatives for the purpose of allocating a micronutrient profile for analysis. Usual were calculated using Multiple Source Method (MSM) (Harttig et al., 2011). Mean usual micronutrient intakes were compared with the estimated average requirements (EAR) (WHO and FAO, 2004). Usual intakes in this context are only valid for the lean season in which the data was collected, not for the entire year. The EAR estimates the average daily nutrient intake needed for half of the healthy population in a particular age and gender group. The EAR cut-point method to was used to assess the proportion of participants whose usual nutrient intake falls below the EAR (National Academies Press, 2000).

Critical Reflection:

Together, chapters 3 and 4 provided a comprehensive snapshot of Baniata's local food system through participatory qualitative FGDs and quantitative nutrition surveys. This mixed methods approach provided an opportunity to assess local food systems combining local narratives with a suite of diet quality and health indicators. Findings from this chapter provide insights into the sustainability of the local food system by linking agricultural production practices with nutrition and health outcomes.

The nutrition surveys in chapter 4 provided an in-depth examination of the usual dietary intakes of primary female agri-food producers within 30 households in a rural Solomon Island village (out of ~85). This study's dietary assessments were only conducted with the primary cook from each household and do not represent the entire household's intake. However, women of reproductive age are often the most nutritionally vulnerable within a household (Ramakrishnan et al., 2012). The 24hr MPR methodology has not been adapted for a Solomon Islands population, however, we countered this limitation by using the Goldberg cutoff methodology to reduce the likelihood of under- and over-reporting (Black, 2000). Data collection occurred during the lean season – this limited the study's capacity to assess the seasonal dietary fluctuations throughout the year, but it provided an annual assessment of household food insecurity. Not all locally cultivated and wild collected foods have unique nutrient composition profiles analyzed, therefore, the researcher had to substitute many local varieties for regional or global foods. This was not the case for imported and processed foods, as these foods had available nutrition fact labels. This study relied on convenience sampling for the assessment of usual dietary intakes and this posed a limitation – only willing, able, and participants could be interviewed.

Overall, this study provides the first recent understanding of dietary intake and agrobiodiversity in relation to health in Solomon Islands. These findings help illustrate the movement of the food system and its overall contribution to nutrition and health outcomes.

Chapter 5 Aims and Methods

Title: *Assessing food system and nutrition transitions among three geographically distinct Indigenous food systems in Solomon Islands (Melanesia)*

Aims:

Chapter 5 aimed to expand upon the findings from Chapters 3 and 4 to include additional people in diverse geographies. The aim of Chapter 5 was to assess nutrition transitions by comparing quantitative anthropometric measurements, diet quality measurements, and food sourcing patterns among three geographically unique rural and urban Indigenous Solomon Island populations. Chapter 5 compared food sourcing patterns – cultivated, wild, market, store-bought, ultra-processed, and takeaway foods – in the three unique populations. Key informant interviews were also conducted within each village to garner contextual perspectives about current and anticipated food system trends. Additionally, qualitative key informant interviews were used to contextualize the quantitative data by identifying emerging concerns towards healthy and sustainable foods systems. Quantitative data were collected through the administration of a comprehensive nutrition survey and participatory quantitative interviews with village elders and other key informants.

Methods:

Chapter 5 is a continuation of the methodology and data analysis in Chapter 4; the study took place in two additional geographically distinct Solomon Island populations, including representation from both rural and urban populations. The two rural study sites are distinguished by their access to the ocean, which provided insights into the dietary differences between those with and without access to the ocean. The urban study site was in the capital city of Honiara, which a distinctive food environment, unlike the two rural areas. Eight local dietitians/nutritionists from the Solomon Islands National University attended a multiday training to ensure comprehension of the research methodologies prior to implementing the quantitative nutrition survey assessments and qualitative focus group discussions at each study site. Using 24hr MPR, quantitative nutrition surveys were administered to collect detailed dietary intake information among the women in each participating household who were primarily responsible for household food preparation and agri-food cultivation. In addition to the methods in Chapter 4, this study assessed participants’ physical activity through the use of an assessment tool known as IPAQ-SF (Lee et al., 2011), which was adapted to include culturally relevant physical activities within the community, such as farming, walking, and playing soccer. Qualitative key informant interviews were held with each village’s elder—and additional community members—to obtain similar FGD information from Baniata (chapter 3). To compare quantitative data collected in Chapter 4 and 5, a one-way ANOVA was used to determine intra-village differences in anthropometric, lifestyle, and diet quality data. Normality checks and Levene's test were conducted and the assumptions met. Key informant interviews comprised a series of structured questions which included reflections on current food system trends, villagers' dietary patterns and preferences, and cultural considerations and taboos.

Critical Reflection:

Chapter 5 utilized similar methods as Chapter 4 but provided a wider sample of Solomon Islanders living in diverse areas of the country; rural coastal (n=30 households), rural inland (n=32 households), and urban (n=33 households). The 24hr MPR methodology has not been adapted for a Solomon Islands population, however, we countered this limitation by using the Goldberg cutoff methodology to reduce the likelihood of under- and over-reporting (Black, 2000). Similar to Chapter 4, food composition tables contain a dearth of information on endemic agrobiodiversity in Solomon Islands.

Findings from Chapter 5 allowed for the comparison of diet quality and anthropometrics across rural and urban populations, as well as populations with and without access to ocean-sourced foods. Clear anthropometric, diet-quality, and sourcing differences were found between rural and urban participants. We found urban populations to be at a significantly increased risk for obesity and NCDs. Estimated requirements of zinc, iron, folate, and vitamin Aeg were met by the majority of participants after fortification mandates in November of 2018 for rice, flour, and oil were enacted in November 2018. Overall these findings contribute to the understanding of the sustainability of Indigenous food systems in Solomon Islands by linking consumption of foods (wild collected, cultivated, and purchased) with dietary intakes and health outcomes – all key components of understanding the sustainability of food systems.

Chapter 6 concludes this thesis with a discussion, drawing on findings from Chapters 2-5. Chapter 6 discusses this thesis' main findings with supporting evidence from external publications to answer the primary research question of "are present-day Indigenous food systems in Pacific Small Island Developing States (PSIDS) sustainable?".

Appendices

- **Appendix A**: Health and Other Impacts of Community Food Production in Small Island Developing States: A Systematic Scoping Review [Published]
- **Appendix B**: Sustainable Diets and Food-Based Dietary Guidelines [Published]
- **Appendix C**: Can Leveraging Agrobiodiverse Food Systems Help Reverse the Rise of Malnutrition in Pacific Small Island Developing States (PSIDS)? [Conference Proceedings]
- **Appendix D**: Ngali nut (Canarium indicum L.) Nutrient Analysis
- **Appendix E**: Training manual for Solomon Island Nutritionist Enumerators
- **Appendix F**: Nutrition Survey for Solomon Islands Research
- **Appendix G**: Research Approval Documents
- **Appendix H**: Leveraging Agricultural Biodiversity for Sustainable Diets, Highlighting Pacific Small Island Developing States [Published]
- **Appendix I**: Dietary Assessment Methodologies in PSIDS: A Scoping Review
- **Appendix J**: Multimedia Content
- **Appendix K**: Copyrights

1.11 Ethics and confidentiality

Research was categorized as low-risk research by the Massey University Human Ethics Committee prior to commencement. Research permits were received from the government of Solomon Islands, and the village elder of each community granted permission prior to commencement of research. Ethics approval and research permits appear in Appendix G. Each participant was required to complete a consent form in the universally used Pidgin language, ensuring full understanding of the purpose of the project and entitling participants to withdraw at any time. All data were kept in secure, locked locations.

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Chapter 2: Progress Towards SDG 2: Zero Hunger in Melanesia – A state of data scoping review [Published PDF]

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Progress Towards SDG 2: Zero Hunger in Melanesia – A state of data scoping review.

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Progress towards SDG 2: Zero hunger in melanesia – A state of data scoping review

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ABSTRACT

This is the first review to examine progress and barriers towards achieving food security in Melanesia as defined by United Nations Sustainable Development Goal 2: Zero Hunger and its component targets. Globally, Indigenous Peoples makeup ~5% of the global population and are responsible for protecting ~80% of the world's biodiversity. Indigenous Melanesians live within one of the most biodiverse regions in the world, however our findings suggest that traditional agrobiodiversity and food system knowledge are being lost to urbanization, lifestyle changes, imported foods, and deforestation. While progress has been made in reducing stunting and wasting, considerable efforts are still required to reverse the rising rates of NCDs and achieve food security in Melanesia. Future strategies should focus on promoting nutrition education, improved education for women, increasing agrobiodiversity within food systems, sustainable seafood production, diversification of protein sources, equitable market opportunities, and crafting trade agreements with insights from public health professionals to encourage health over profits. Strong participatory strategies inclusive of traditional knowledge are essential if Melanesia aims to progress towards the targets outlined in SDG 2: Zero Hunger.

1. Introduction

Pacific Small Island Developing States (PSIDS) are uniquely facing a 'global syndemic' – or the triad of obesity, undernutrition, and climate change (Swinburn et al., 2019). Today, diet-related non-communicable diseases (NCDs), such as cardiovascular disease (CVD) and type 2 diabetes mellitus (T2DM), are the leading cause of death across the Pacific (Hawley and McGarvey, 2015). Pacific Small Island Developing States (PSIDS) are home to nine of the ten countries with the highest rates of global obesity (BMI > 30; obesity prevalence range 45–68%), and seven of the ten countries with the highest rates of Type 2 Diabetes Mellitus (T2DM) globally (adult T2DM prevalence range 18.6–30.%) (WHO, 2014b). Climate changes coupled with population growth are predicted to intensify all forms of malnutrition across PSIDS through the amplification of current incidences of NCDs (Savage et al., 2019). The Pacific Islands have contributed negligible anthropogenic greenhouse gas emissions, but disproportionally experience the deleterious impacts of the Anthropocene, or human-caused climate impacts (Lal et al., 2009; Savage et al., 2019). Pacific peoples recognize their vulnerabilities and agree that culturally appropriate adaptation strategies are needed to help mitigate future food and climate challenges (Savage et al., 2019).

PSIDS are divided into three ethnogeographic regions: Micronesia, Polynesia, and Melanesia (Goldberg, 2018). Melanesia includes Papua New Guinea (PNG), Solomon Islands, Fiji, Vanuatu, and New Caledonia, which contain the majority of land mass and over three-fourths of Indigenous Peoples living in PSIDS (Foster, 2020). Building sustainable and resilient food systems is essential to ensuring food and nutrition security and healthy diets for present and future generations across the Pacific, however, significant knowledge gaps exist regarding the best strategies to achieve these goals for these vulnerable nations. The magnitude of hunger varies widely across Melanesia, from low food insecurity to severe. This review aims to examine and synthesize the latest published literature in Melanesia regarding the multiple targets of United Nations Sustainable Development Goal 2: Zero Hunger.

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2. Malnutrition in Melanesia

Malnutrition includes undernutrition (wasting, stunting, underweight), micronutrient deficiencies, overweight, obesity, which result in diet-related noncommunicable diseases (WHO, 2014a). There has been some progress in Melanesia towards reducing malnutrition; as rates of stunting, wasting, and underweight children, as well as anemia in women have been steadily declining (Table 1). However, the prevalence of overnutrition, leading to overweight and obese Melanesian children and adults, has been rising (Table 1). These changes are associated with increases in Type 2 Diabetes Mellitus and hypertension (Micha et al., 2020). Food insecurity data are limited, but the Solomon Islands Government have recently reported that every region has experienced some level of food insecurity (SINSO, 2017). Vitamin A micronutrient deficiencies in Melanesia were classified by the WHO as 'mild' (WHO, 2009), however no recent regional data exist to support these findings in light of nutrition transitions.

Lower income households in PSIDS are less likely to experience obesity and diet-related NCDs compared with higher income households (WHO, 2017). Melanesian countries also have significantly lower obesity rates than Polynesian or Micronesian countries, possibly related to a slower nutrition transition away from traditional foods, cultural differences, or genetic variances (GNP, 2020).

3. Population growth

Melanesian countries are projected to have significant rises in population by 2050, which will increase pressure on local food systems and amplify existing malnutrition. The total population of Melanesia, 11.1 million in 2020, is expected to rise to 17.4 million by 2050 (UN, 2019b). Population growth is most notable in Papua New Guinea (2.9% growth annually), Solomon Islands (2.5%), and Vanuatu (2.4%) (UN, 2019a). Increased populations will amplify land and natural resource use.

4. A Nutrition transition

Nutrition transitions away from traditional diets are accelerating global malnutrition (Popkin, 2017). Most Melanesian populations live in rural villages and rely heavily on subsistence agriculture (Andersen et al., 2013). However, rapid urbanization is underway, as villagers seek enhanced economic opportunities (Albert et al., 2020). Tradeoffs from urbanization include a shift away from traditional diets in favor of imported and ultra-processed foods with poorer nutrient quality, and changes in the built environment that are less conducive to physical activity (Popkin, 1999; Sievert et al., 2019). White rice often displaces traditional staple foods due to its cost, taste, and convenience, and can be used as a proxy for the displacement of traditional foods and changes in dietary patterns (Peng et al., 2020; Vogliano et al., 2020). Fig. 1 shows increased white rice availability trends in Melanesia from 1961 to 2013 (FAO, 2020). (Data for PNG were unavailable.)

5. Climate vulnerability of Melanesia

Food and nutrition insecurity across Melanesia is compounded by rising sea levels, warmer ocean temperatures, heavier rainfalls, and increases in cyclone frequency (Savage et al., 2019). Invasive species (pests, weeds, and disease) already threaten native island diversity, and increased rates of *trans*-boundary species are predicted to increasingly threaten Pacific Island ecosystems and livelihoods (Taylor & Kumar, 2016). Due to equatorial proximity, the Pacific Ocean surrounding Melanesia has risen more than anywhere else in the world, with an average annual increase of 1 cm (global average 3 mm) (Melillo et al., 2017). Numerous low-lying communities have reported saltwater intrusion into crops, hindering crops such as swamp taro and cassava and contaminating freshwater resources. The diverse topographies of Melanesian countries may provide a short-term buffer against sea-level rise. Sea temperatures are rising, resulting in coral bleaching and declining coastal seafood catches (Dohan et al., 2011). Higher temperatures result in stronger storms and cyclones, which can devastate local agriculture as evidenced by Cyclone Harold, a Category 5 tropical cyclone that inflicted widespread damage across Melanesia in 2020. Vanuatu's local food systems are still recovering from Cyclone Pam in 2015, which increased their reliance on imported foods (Dohan et al., 2011). Most Indigenous communities are coastally located and will likely require relocation to higher elevations in coming decades (Brodie et al., 2013). Urban infrastructures must also adapt, posing significant financial burdens on low-income PSIDS.

6. Linking agriculture, Nutrition, and health

6.1. Agricultural biodiversity

Melanesia's distinct agricultural biodiversity, or agrobiodiversity, is of particular importance when countries seek to improve food and

Table 1
SDG 2: Malnutrition trends within Melanesia*.

Indicator	Solomon Islands				Fiji				Papua New Guinea				Vanuatu			
	Rate	*Year*	*Rate*	*Year*	*Rate*	*Year*	*Rate*	*Year*	*Rate*	*Year*	*Rate*	*Year*	*Rate*	*Year*	*Rate*	*Year*
Stunting (Avg. M/F)	32.8%	2007	31.6%	2015	–	–	7.5%	2004	43.9%	2005	49.5%	2010	25.7%	2007	2.5%	2013
Wasting (Avg. M/F)	–	–	8.5%	2015	–	–	6.3%	2004	–	–	14.1%	2010	5.9%	2007	4.4%	2013
Child Underweight (F)	8.3%	2000	6.3%	2016	9.8%	2000	8.8%	2016	7.9%	2000	5.8%	2016	7.9%	2000	6.1%	2016
Child Underweight (M)	11.5%	2000	8.8%	2016	13.5%	2000	11.4%	2016	11.4%	2000	8.5%	2016	11.3%	2000	8.7%	2016
Child Overweight (F)	19.4%	2000	30%	2016	3%	2000	39.5%	2016	24.2%	2000	37.7%	2016	24.7%	2000	37%	2016
Child Overweight (M)	8.1%	2000	16.7%	2016	17.8%	2000	29.3%	2016	12.6%	2000	25.9%	2016	12.2%	2000	24.5%	2016
Child Obesity (F)	1.4%	2000	5%	2016	6%	2000	11.4%	2016	3.7%	2000	10.1%	2016	3%	2000	8.3%	2016
Child Obesity (M)	0.9%	2000	3.7%	2016	5.1%	2000	11.2%	2016	3.3%	2000	9.3%	2016	2.6%	2000	8%	2016
Adult Diabetes (F)	11%	2002	15.1%	2014	14%	2000	18.9%	2014	9.8%	2000	14.3%	2014	11.1%	2000	16%	2014
Adult Diabetes (M)	9.8%	2002	12.6%	2014	11%	2000	15.9%	2014	10.7%	2000	15.4%	2014	11.1%	2000	15.7%	2014
Adult Overweight (F)	48.2%	2000	60.5%	2016	58.4%	2000	67.7%	2016	46.5%	2000	58.1%	2016	50.3%	2000	62%	2016
Adult Overweight (M)	37.7%	2000	49.6%	2016	48.2%	2000	59.9%	2016	37.6%	2000	47.4%	2016	40.7%	2000	52.2%	2016
Adult Obesity (F)	17.7%	2000	27.1%	2016	26.5%	2000	35.3%	2016	17%	2000	25.8%	2016	20.2%	2000	30.1%	2016
Adult Obesity (M)	9.4%	2000	17.9%	2016	15.4%	2000	25.1%	2016	9.4%	2000	16.6%	2016	11.3%	2000	20.2%	2016
Raised blood pressure (F)	21.3%	2001	23.6%	2015	22.7%	2000	20.7%	2015	22.5%	2000	25.8%	2015	22.4%	2000	24.1%	2015
Raised blood pressure (M)	20.1%	2001	20.4%	2015	23.7%	2000	22.4%	2015	22.9%	2000	25.1%	2015	23.4%	2000	24.2%	2015
Anemia in Women (all)	51.6%	2000	48.6%	2016	33.8%	2000	31%	2016	37.5%	2000	36.6%	2016	37.2%	2000	24%	2016
Sodium intake (g)	–	–	3.2	2017	–	–	3.5	2017	–	–	3.3	2017	–	–	3.3	2017

*Data were sourced from the 2020 Global Nutrition Report. Data for New Caledonia were not available.

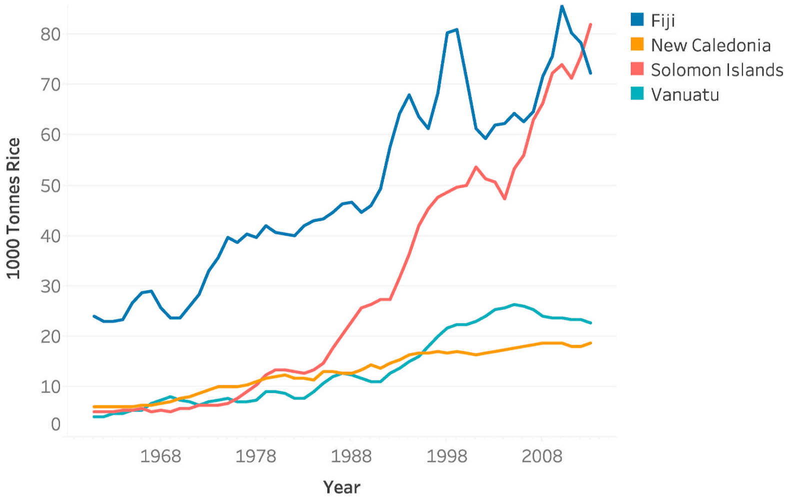


Fig. 1. Rice availability in Melanesia* (1961–2013).

nutrition security and increase resilience from climate-related shocks (Burlingame et al., 2019). Melanesian ecosystems and agroecological zones are amongst the most diverse in the world. Agrobiodiversity contributes to defining and maintaining cultural identities and livelihood diversity (Zimmerer and Vanek, 2016) and can improve nutrition security in low- and middle-income countries (Jones, 2017). Therefore, biodiversity conservation is fundamental to sustaining ecosystems upon which human survival and well-being depend (Sandifer et al., 2015). Unfortunately, biodiversity has been dramatically declining in Melanesia due to largely unregulated forestry industries, erosion, monocropping, and changes in land use (Brodie et al., 2013). Loss of biodiversity translates to fewer species and loss of variety diversity and damage to the functioning of ecosystem services, which have been traditionally been relied on for food, clean water, fibre, and medicine (Burlingame and Dernini, 2012).

7. Sustainable food systems

Sustainable food systems are crucial to ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture that is both productive and resilient to climate changes (Fanzo et al., 2020). According to the Committee of World Food Security (2020), food security and nutrition policy are best approached within a sustainable food system framework underpinned by the right to access food (HLPE, 2020). Ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture that is both productive and resilient to climate changes are the foundations of UN SDG 2. According to the United Nations, SDG 2 aims to:

Ensure that everyone everywhere has enough good-quality food to lead a healthy life. Achieving this goal will require better access to food and the widespread promotion of sustainable agriculture. This entails improving the productivity and incomes of small-scale farmers by promoting equal access to land, technology and markets, sustainable food production systems and resilient agricultural practices. It also requires increased investments through international cooperation to bolster the productive capacity of agriculture in developing countries *(*UN, 2015*)*.

Achieving SDG 2 in PSIDS requires significant and immediate attention. Each Pacific island is confronted with unique challenges to food security, influenced by land topography, soil quality, freshwater accessibility, coastal access, and traditional knowledge transmission (Hawley and McGarvey, 2015; Swinburn et al., 2019; WHO, 2017). Natural disasters, population growth, and impacts of the Covid-19 pandemic will add to the intricacies of achieving food and nutrition security (Farrell et al., 2020).

8. Scoping review aims

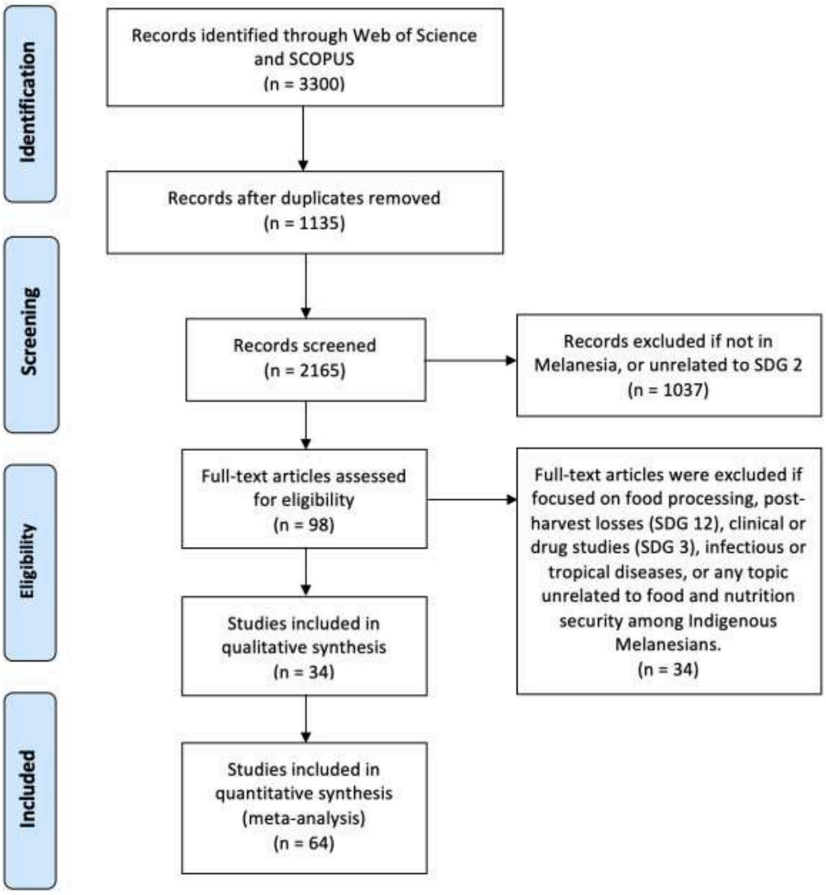
This review aims to synthetize the state of data published from 2010 to 2020 related to UN SDG 2: Zero Hunger across Melanesian countries. The scope of this review is broad, and data are limited. This scoping review aims to examine the following:

- What progress has been made towards reducing the multiple burdens of malnutrition across Melanesia?
- What trends exist regarding agricultural productivity and diversity among Indigenous subsistence farmers in Melanesia?
- What recommendations are suggested to advance the goals of SDG 2: Zero Hunger and associated targets (2.1–2.5)?

9. Methodology

A comprehensive search strategy was developed in collaboration with a Massey University librarian within the databases SCOPUS and Web of Science (Appendix A) to conduct this scoping review of the literature. The purpose of the scoping review was to map a wide range of literature trends, gaps, innovative approaches, and recommendations (Arksey and O'Malley, 2005). Search terms included variations of sustainable food, agriculture, nutrition, hunger, food security, diet, malnutrition, biodiversity, and agrobiodiversity, each combined with a location including Melanesia, Fiji, Solomon Islands, Papua New Guinea (PNG), Vanuatu, and New Caledonia. Eligibility requirements for the search were publications within the past ten years (2010–2020), published in English as full, peer-reviewed articles. A date limit of 10 years ensures more relevant data associated with the review aims. Records were identified through Web of Science and SCOPUS databases. Publications were organized, annotated, and managed using EndNote (Version X 9.3.3). Duplicate entries were removed. Titles were screened twice by different researchers for their relevancy to SDG:2 and its five associated targets. Articles were excluded if they did not feature one of the five Melanesian states, were clearly unrelated to target aims, or the full article was unable to be accessed. Further eligibility criteria excluded articles related to food processing, post-harvest losses (SDG 12), clinical or drug studies (SDG 3), infectious or tropical disease, or any topic unrelated to food and nutrition security among Indigenous

Melanesians. A modified PRISMA Extension Checklist for scoping reviews was used to assess each study for appropriate participant selection and sample size (when applicable), adequate description and utilization of methodology, appropriate discussion and interpretation of findings, risk of bias based on industry-funded studies, and limitations (Tricco et al., 2018). Studies conducted outside of Melanesia were excluded. Given the broad scope of this review, data were not directly compatible and were summarized thematically into one of five of the SDG #2 targets.



10. Results

Publications included in this scoping review have been thematically organized according to the five SDG 2 targets from SDG 2.1 to SDG 2.5. The United Nations defines the targets as follows, with relevant sources evaluated after each. Table 2 features the number of studies from each country, with associated themes.

By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round.

11. Dietary diversity and quality

Dietary diversity is used as a proxy for diet quality and was assessed in the rural provincial capital of Auki, Solomon Islands (pop. 7780), by identifying a total of 96 foods consumed by men and women through 24-h dietary recalls (n = 133); (Horsey et al., 2019). The most commonly consumed foods were starchy staples and cereals (94.7%), followed by vegetables including dark leafy greens (89.5%), seafood including canned tuna (84.2%), and fruit (68.4%). Least-consumed food groups included nuts, seeds and legumes (39.8%), dairy (18.8%), meat (14.3%), and eggs (13.5%) (Horsey et al., 2019). Dietary diversity in this rural population was moderately high when compared to Western dietary patterns, and qualitative data indicated that Indigenous Solomon Islanders enjoy traditional and local foods and would prefer to continue eating them if possible.

Higher consumption of dark green leafy vegetables and higher dietary diversity were associated with decreased rates of obesity (n = 114) (Tsuchiya et al., 2017). Conversely, modest increases in ultra-processed foods in both rural and urban settings were found to increase risks of diet-related NCDs such as obesity (Dancause et al., 2013). Consumption of ultra-processed foods best predicted overweight and obesity in an adult Vanuatuan population, as found in a multiple correspondence

Table 2
Progress towards SDG 2: Zero Hunger across Melanesian countries from thematic analysis of reviewed literature by geographic area (n = 64). SDG 2.1

Country	Number of papers	Thematic analysis
Melanesia	20	Trade policy and health, soda taxes, bee conservation for food security, micronutrient deficiencies, agrobiodiversity, canned tuna for food security, fisheries, agroecology, climate change and food security, sustainable land management.
Fiji	15	Policy interventions for NCDs, Adolescent dietary pattern, Weight stigmas and quality of life, Lifestyle and risk factors, Food culture, Diabetes, obesity, Food industry and public health, Trade policies and nutrition, food security, social-ecological linkages, agroecology, dietary diversity.
Papua New Guinea	11	Bananas and beta-carotene content, micronutrient deficiencies, palm oil production and food security, breastfeeding knowledge and practices, socioecological determinants of health, gut microbiota, on-farm diversity, child nutrition, sweet potato cultivation trends.
Vanuatu	10	Economic development and health, behavior and obesity, food production systems, cost of diets, agroecology, agrobiodiversity, child food security, obesity and NCDs.
Solomon Islands	7	Agricultural cultivation systems, fish and food security, genetic variants related to obesity (SNPs), Sustainable food systems, obesity, diet diversity and preferences.
New Caledonia	1	Sociodemographic considerations related to obesity.

analysis (MCA) (van Horn et al., 2019).

12. Dietary contributions from seafood

Melanesian countries rely heavily on fish as a primary source of protein and other essential nutrients, particularly among Indigenous villagers living in coastal villages. In addition to fresh fish, canned fish (tuna) is a critically important source of high-quality protein, vitamins, minerals, and omega-3 fatty acids for inland populations without ocean access and during times of seasonal food insecurity (Bell et al., 2019). Four species of tuna fish dominate the fishing industries across PSIDS: skipjack (*Katsuwonus pelamis*), yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus*), and albacore tuna (*Thunnus alalunga*). Table 3 includes extracted findings from a systematic review examining fish consumption data across Melanesia (Charlton et al., 2016).

Food system tradeoffs are common, and as Melanesians continue to urbanize by moving to cities for improved economic opportunities, many individuals experience food security tradeoffs. Food and nutrition insecurity in urban populations are increasingly visible to locals during social gatherings known as *lafets*, particularly among children. For instance, Vanuatuan women organizing in the urban center of Port Vila have noticed an increase in children outside of the social event joining *lafets* food lines due to hunger, and women have adapted their traditional practices to provide food for these hungry children (Wentworth, 2016).

The poorest Vanuatuan households would need to allocate 40.9% (SD 34.3%) of their total food expenditure ($16.50 USD) to achieve the World Health Organization's recommendation of >400 g of non-starchy fruits and vegetables daily (Jones and Charlton, 2015). More research is needed to understand how economic barriers influence dietary diversity, and if cultivated foods contribute to food and nutrition security among the poorest urban households.

13. SDG 2.2

By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under five years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.

Table 3
Fish consumption across Melanesia*. Urbanization and Food Insecurity Challenges.

Country	Findings
Papua New Guinea	Four villages were surveyed (two high altitude, one middle, and one low), and found that fish catches were the most important source of protein for residents living in lower altitudes (41% of all animal sourced proteins), while higher altitude villages relied more heavily on purchased proteins (canned fish and lamb mutton).
Solomon Islands	A cross-sectional study from five villages in the Roviana Lagoon found that most households consumed fish as the primary source of protein (no quantitative data listed). Another study from the isolated island of Tikopia found 72% of households consumed fresh fish daily and canned fish was eaten rarely.
Fiji	One study conducted in a rural Fijian found that seafood made up 37% of dietary protein, followed by cereals 29.2% and meat 13%.
Vanuatu	Adults consuming fresh fish ranged from 10-50% depending on the population. Coastal villages consumed more than urban populations. Canned fish was consumed more frequently among children than was fresh fish, with 40% of children in one study consuming canned fish on a daily basis.
New Caledonia	Three studies assessed fish intake in New Caledonia. In the Northern Province, 85% of adults participating in a study of subsistence fishing practices reported consuming fresh fish one or more times a week, with 45% consuming fresh fish 2–3 times/week and 11% 1–2 times/day. The majority of fish consumption was from subsistence means (92%) and minimal was purchased (8%).

*(Charlton et al., 2016)

14. Malnutrition in Melanesia

Malnutrition includes lacking proper nutrition by not having enough food to eat, inadequacy diversity of nutrients, or lack of access or knowledge to consume healthy foods. Melanesia's regional nutrient availabilities were calculated from the UN's Food and Agriculture Organization (FAO) food balance sheets data, which examine country-level data on food imports, exports, and production (Rosalind and Cavalli-Sforza, 2012). While these high-level data do not represent all populations, they indicate possible deficiencies in essential micronutrients across Melanesia (Table 4). For the first time in over five decades, Melanesia has experienced a reemergence of beriberi, a disease caused by thiamin (vitamin B_1) deficiency (Nilles et al., 2018). While the cause of nutritional deficiencies is unknown, they are suspected to be associated with transitions away from traditional diets and towards Western diets.

A systematic review found severe pediatric malnutrition in Papua New Guinea was associated with 11% of pediatric hospital admissions and 33% of childhood deaths in 2017 (McGlynn et al., 2018). Malnutrition persists due to low levels of exclusive breastfeeding, lack of access to infant formulas for special needs cases, social deprivation, lack of knowledge, low-quality foods during complementary feeding, acute and chronic disease, and TB/HIV (McGlynn et al., 2018). Low protein and

Table 4
Nutrient deficiencies across Melanesia (extracted from FAO STAT).

Country	Riboflavin (Vitamin $B_{2)}$	Vitamin A	Calcium	Iron	Zinc
Solomon Islands	X	X	X	X	X
Fiji	X	X	X	X	X
Papua New Guinea	X		X	X	X
New Caledonia			X	X	X
Vanuatu	X	X	X	X	X

iron intakes, lower socioeconomic status (SES), and living in an urban setting were associated with poorer pediatric health outcomes (McGlynn et al., 2018). Breastfeeding is effective way to achieve optimal growth, development and health in children and is regarded by most Papua New Guinean mothers as 'good' (87.9%). However, 27% of husbands were reported to encourage women to shorten breastfeeding, due to widespread cultural prohibitions against sex during breastfeeding (Kuzma, 2013). Food restrictions and taboos against breastfeeding were practiced by most PNG women (57%), and breaking taboos was thought to curse the child (Kuzma, 2013). Exclusive breastfeeding may also be shortened due to women needing to return to work. These findings are not representative of all populations living throughout Melanesia. Results from a multi-faceted child malnutrition intervention in a PNG population found educational seminars, posters, reminders from doctors and nurses, adequate supplies of breast milk, and infant formulas as a part of moderate to severe acute malnutrition intervention to significantly improved pediatric malnutrition and health outcomes (Landi et al., 2017).

15. NCDs

Despite numerous public policies and program interventions, the incidence of NCDs in Melanesia, including type 2 diabetes mellitus (T2DM), CVD, and obesity, has risen rapidly over the past three decades due to diet and lifestyle transitions towards more Western style diets. Heart disease risk factors within a diverse PNG population (n = 671) were estimated through biochemical assessments and lifestyle factors, which identified that all adults risked cardiovascular disease (CVD) regardless of socioeconomic status (Rarau et al., 2019). Life expectancy for Fijians has not improved since 1985, and national T2DM rates have increased from 7.7% (1989) to 15.6% (2011) (Lin et al., 2016). Self-reported annual costs of managing T2DM in Solomon Islands totaled $281 AUD ($187 USD) person/year, and $4.5 million AUD ($2.9 million USD) annually for the entire country (Tin et al., 2015).

Genome-wide association studies have identified proposed genetic variances (single nucleotide polymorphism; SNPs) within Indigenous Melanesian populations related to living in tropical environments and consuming diets rich in starchy root crops (n = 561 Solomon Islanders) (Furusawa et al., 2017). These variances may increase metabolic and cardiovascular diseases. However, inflammatory diseases often found in Western cultures, such as irritable bowel disease and autoimmune diseases, such as type 1 diabetes mellitus and rheumatoid arthritis, are rare in Melanesia. Results from a gut microbiota study of Papua New Guinean participants found higher microbial diversity and a lower inter-individual variation when compared to those living in the USA, which is known to be protective factor against inflammatory diseases (Martínez et al., 2015).

16. Childhood obesity

Childhood obesity is a growing public health concern across Melanesia, as every country is experiencing rapid rises in obesity rates (Table 1). Three studies in Fiji and New Caledonia examined obesogenic factors and quality of life indicators among children. A survey administered to Fijian adolescents (ages 13–18; n = 6871) found that 90% of adolescents consumed sugar-sweetened beverages and 13% consumed fried foods on all or most days of the week, while 74% consumed minimal fruits and vegetables (Wate et al., 2013). Complementing these findings, a nutrition survey examined obesity trends among ethnically diverse New Caledonian adolescents (n = 621) and identified that skipping breakfast, lower SES households, and being Melanesian were primary indicators associated with overweight and obesity (Frayon et al., 2017). No meaningful self-esteem differences were found between normal weight and obese Fijian children (n = 8948), contradicting Western perceptions of body size and perceived health-related esteem (Peterson et al., 2014).

17. Sociocultural and economic influences on diets

Sociocultural and economic influences have been identified within two studies in PNG and Solomon Islands, which have been linked with significant changes in dietary patterns. Following rural migrants to the urban center of Port Moresby, PNG, researchers found that higher-SES participants consumed more traditional foods, were less physically active, and had higher BMIs compared with lower-SES participants. Reduced physical activity among higher-SES participants was attributed to concerns about unsafe streets and high urban crime rates in Port Moresby (Vengiau et al., 2014). However another study found higher-SES, educated urban Solomon Islands participants had healthier body weights (Tsuchiya et al., 2017). Both studies highlighted that higher-SES populations can afford traditional foods that are cost-prohibitive for lower-SES populations living in urban environments.

18. Trade and policy in Fiji

Trade policies and agreements have substantially influenced food availability, quality, and environments across Melanesia, and implications were featured in nine studies over the past decade, primarily in Fiji. Trade policies such as World Trade Organization (WTO) membership (signed in 1996) have increased imports of healthy foods, such as fruits and vegetables, but also imports of ultra-processed and less healthy foods, including refined fats and oils; meat; processed dairy products; energy-dense beverages; and packaged foods (Amerita et al., 2017).

Publicly available documents contain no reports of food industry influence or lobbying in Fiji. However, in stakeholder interviews with Fijian public health professionals, researchers identified inconsistencies between public corporate reports and actual activities intended to influence political action. These health professionals identified food industry marketing and policy tactics as potential determinants of ill health (Mialon et al., 2016). An extracted quotation below highlights the consensus among the interviewed public health professionals.

"Nestlé were providing nutrition education in schools. They were coming to the schools, talking about good nutrition, how to eat healthy diets, and at the same time, giving children samples …. Other examples include national sporting events sponsored by companies such as Coca-Cola and Chow instant noodles (pp. 6–7)".

To combat the rise in NCDs, Fijian lawmakers implemented two soft drinks taxes in 2006. The first was an import excise duty of 5%, the second an excise duty of $0.05 cents/liter on locally products. These taxes were reduced in 2007, largely due to heavy lobbying from the domestic soft drink industry, which argued that the tax eroded their profits (Thow et al., 2011a,b).

Fijian policy makers (n = 31) acknowledged that scientific evidence was only sometimes used when developing food policies and that fiscal benefits were key to gaining government support (Waqa et al., 2017). A group of multi-sectoral stakeholders in Fiji and Tonga identified the five most effective policies for combating NCDs and concluded that fiscal policies impacting imported foods and value-added taxes were most effective (Snowdon et al., 2011). Additional food policy strategies included increasing access to high-quality local foods, modifying costs of healthy foods and less healthy foods/drinks, aligning tariff schedules with the healthfulness of foods, restricting unhealthy imports, investing in rural and agricultural development, investing in processing healthy traditional foods, and building healthier food environments including schools (Snowdon et al., 2010; Thow et al., 2011).

19. SDG 2.3

By 2030, double the agricultural productivity and incomes of small-scale food producers, in particular women, Indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment.

20. Agricultural productivity and income generation

A nutrition-sensitive food systems approach is essential for ending hunger and malnutrition through improved access to diverse and nutrient-dense foods while generating income through agri-food sales. Agri-food sales are the primary income source for most Indigenous peoples in Melanesia. Doubling agricultural productivity and incomes of small-scale food producers and fishers – particularly Indigenous women – is a key target outlined by SDG 2.3. Three studies assessed agricultural pressures, production diversity, and agri-food market conditions in Vanuatu, PNG, and Solomon Islands.

Population density and increased land pressures were identified as primary influences on land productivity (fallow length) in six Vanuatuan villages (Lebot and Siméoni, 2015). Indigenous small-scale food producers in PNG are increasingly shifting cultivation away from agro-biodiverse crops towards monocultured palm oil plantations to meet rising global demands for palm oil and increase household incomes. Expanding palm oil production may provide short-term economic gain for Indigenous farmers, but the reduction of on-farm diversity leaves farmers vulnerable to global market fluctuations for a single crop (Koczberski et al., 2012). Indigenous farmers may not realise the food security risks of homogenised agricultural production, nor the food and nutrition security benefits of growing a diverse range of foods.

Once food is cultivated, marketplaces are not always accessible, safe, sanitary, or equitable. A recent series of focus group discussions with Solomon Islanders revealed significant concerns over safety, pricing fairness, and sanitation at the country's largest fresh produce market, the Honiara Central Market, and women cited severe concerns about safety, recounting frequent experiences of harassment, pickpocketing, and theft at the market (Nichole and Charles, 2017).

21. Seafood trends and security

Seafood is a nutrient-rich and culturally significant food for many living in PSIDS. Five publications highlighted strategies for securing seafood in a changing climate across Melanesia. Climate change is altering oceanic currents and nutrient supplies and is projected to increase tuna availability in Melanesia (Bell et al., 2013). By 2100, however, tuna availability in Melanesia will begin to decline, warranting thoughtful strategies to achieve short- and long-term food and nutrition security (Bell et al., 2013). The majority of tuna catches are processed into canned tuna. Domestic production of canned tuna in Melanesia varied by country, with Solomon Islands producing ~91% of its domestic needs, Fiji producing ~68%, and Papua New Guinea producing ~39% (Bell et al., 2019). Scaling up tuna canneries is an encouraging short-term transient strategy to improve food security and strengthen food sovereignty while providing economic opportunities for Indigenous Melanesians (Bell et al., 2009, 2015).

In addition to canned fish, small-scale fish catches are a critical source of nutrition and economic opportunity for many Indigenous Melanesians, particularly those with coastal or river access (Charlton et al., 2016). Fish aggregating devices (FADs), widely used to attract fish and improve the quantity of catches, were found to increase fish catches by up to 45% in rural Solomon Island communities (Albert et al., 2014). Purse seine fishing, another technique to increase seafood catches, involves using a vertical net to catch free-swimming schools of fish, has resulted in small but significant increases in catches (Pilling et al., 2015). Authors from both studies conclude that these methods can improve fish catches but alone will not solve food insecurity (Pilling et al., 2015).

As global seafood stocks decline, longer-term solutions such as aquaculture may be required to ensure adequate access to seafood. Aquaculture has been cited as an effective way to improve fish availability, but requires significant financial investment (Bell et al., 2015). Cleasby et al. (2014) examined the potential agroeconomic and nutritional contributions of aquaculture in Solomon Islands and determined that freshwater tilapia (*Oreochromis mossambicus*) was the most accepted fish by Solomon Islanders due to taste, price, and convenience (n = 148). When economic considerations were removed, Solomon Islanders preferred marine reef fish, indicating that traditional fish varieties are preferred to introduced varieties (Cleasby et al., 2014). Authors suggest further investigation of the Indigenous milkfish (*Chanos chanos*) as a cost-effective and culturally accepted alternative that can promote food and nutrition security.

22. SDG 2.4

By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality.

23. Sustainable and resilient food systems

Traditional food systems in Melanesia were designed to provide year-round food and nutrition security. However, changing weather patterns, loss of traditional knowledge, and increases in international trade threaten the production and utilization of traditional foods. Seven studies featured strategies for sustainable and resilient food production in Melanesia, including land use changes, leveraging traditional knowledge, and climate-resilient crops.

Interviews with Pacific leaders have identified population growth and climate change as the most pressing threats to the lives of Indigenous peoples (Cvitanovic et al., 2016). Additionally, land pressures are of concern for future food and nutrition security, with major causes of land degradation including deforestation for large-scale agriculture, commercial logging, mining, pollution, land tenure issues, and climate change (Wairiu, 2017).

However, despite millions of dollars spent on advancing adaptation to climate change in Melanesia, Nunn et al. (2018) argue that little has been achieved in the past 30 years. Researchers argue that ensuring Pacific Islander values are at the heart of adaptation planning is essential for sustainable and effective interventions, and community interventions across PSIDS must be individualized, given the widely diverse cultures that exist among Indigenous Pacific communities (Nunn and Kumar, 2018).

Root crops have been found in Vanuatuan microfossils, indicating pre-colonization cultivation, and coinciding with the first human migrations around 3000 years ago (Sardos et al., 2016). Archaeological evidence suggests that prior to European contact, Melanesians intensified agricultural production systems, including some of the first occurrences of agroforestry systems in the world (Mertz et al., 2012). Colonization and globalization may have increased the vulnerability of most PSIDS by weakening traditional social structures and undermining traditional management practices through the introduction of monocultured agricultural practices and imported processed food items (Sardos et al., 2016).

Leveraging traditional knowledge and culturally important species can improve food security and sovereignty. Sweet potatoes (*Ipomoea batatas*), among the most important sources of nutrition in Melanesia due to their strong ecological and climatic resilience, are a staple food for those living on low-lying islands and in mountainous highlands. Papua New Guineans and Solomon Islanders consume around 670kg/person/year, and sweet potatoes make up ~65% of all food production in Solomon Islands (Iese et al., 2018). They have been documented to fulfil all four pillars of food security, since they can grow in moderate-/low-fertility soil and at high altitudes, tolerate mild droughts, have high tolerance to pests, disease, rain, and mild frosts, are nonseasonal and easily propagated, are cyclone resilient, and have a short growing season. Furthermore, the whole plant is edible by livestock and humans and can be rotated or intercropped with other crops, and the potatoes are nutritious (particularly orange ones), can be consumed raw or value-added, and can be stored for long periods (Iese et al., 2018).

Today, traditional knowledge is threatened by increases in land pressures, loss of soil fertility, increased soil salinity, burning of crops, overreliance on monocultured cash crops and the attendant agrochemicals, increasing dependence on imported foods, medicines, and fuel and overemphasis on agrochemical dependant monoculture production systems (Thaman, 2014). Field surveys from the Papua New Guinean highlands (2005–2014) revealed that fallow periods in the highlands have decreased by 48%, time to walk to gardens has increased by 60%, and 83% more sweet potatoes were sold rather than consumed locally (Fujinuma et al., 2018). Agroecological approaches such as agroforestry and nitrogen-fixing legumes can enhance soil health and promote climate-resilience (Wairiu, 2017).

24. SDG 2.5

By 2020, maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed.

A key component to SDG 2.5 is maintaining the genetic diversity of seeds, cultivated plants, and wild species, as well as promoting equitable access to genetic resources and associated traditional knowledge. Agrobiodiversity in Melanesia was determined to be culturally significant and supportive of food, health, energy, and livelihood security.

Crop diversity in the Pacific began declining in the 1970s, primarily due to commercial monoculture cropping of foods such as taro (Thaman, 2014). Due to narrow genetic variances within monocultures, taro was unable to resist leaf blight, which destroyed cultivation for nearly 20 years (Thaman, 2014). Conversely, agrobiodiversity was found to improve diversity within food production and act as a natural buffer against the spread of pests and diseases (Lebot and Siméoni, 2015).

Data were collected across 122 Vanuatuan gardens, and researchers identified a total 110 species, with traditional gardens hosting an average of 105 species, and modern gardens - characterized by the absence of a copping cycle (i.e. no successive planting of different species) - hosting an average of 67 species (Blanco et al., 2016). These data suggest a trend of moving away from agricultural biodiversity.

Coastal agroforests in Fiji have dominated the landscape for millennium, and are critical for food and nutrition security. However these agroforests are being threatened with increasing pressures (Ticktin et al., 2018). Native Melanesian bee populations – a keystone species for functioning ecosystems - are also on the decline due to habitat loss, fragmentation, agrochemicals, and climate change. Conservation of biodiversity and associated ecosystem services provided are critically important for the livelihoods for Indigenous Melanesian populations (Groom and Schwarz, 2011).

Papua New Guinea alone is home to ~5% of the world's animal and plant species diversity, of which Indigenous peoples have relied on for centuries for medicine, oil, fiber, and dyes (Iramu et al., 2018). Motivations for growing diverse crops among PNG semi-subsistence farmers included improved markets and sales, improve diet diversity, proud exhibitionists (to show off products), novelty of new crops, and being a secondary farmer (Nordhagen et al., 2017), indicating that marketization of agrobiodiverse crops is possible. Eighteen species of traditional vegetables were identified by Papua New Guineans for their nutritional value, availability at the markets, taste, and were commonly prepared for meals (Iramu et al., 2018). Effective approaches towards encouraging increased biodiversity exist and could help improve ecosystem services and diet quality.

Leveraging the genetic diversity and Indigenous knowledge associated with neglected and underused species may provide food-based solutions to combat malnutrition and provide resilience against certain adverse impacts of climate change. One example of a currently underutilized species is the orange-fleshed B-carotene-rich banana (*Musa Fe'i* group), where the richness of the orange flesh colour was correlated with B-carotene content ($r = 0.633$, $p < 0.01$), indicating that the orange flesh of bananas can usefully determine beta-carotene density (Fungo et al., 2010). Scaling up these bananas in populations with low Vitamin A intakes is one food-based strategy towards achieving SDG 2.

Sustainable development and climate adaptation in the Pacific requires new ways to integrate macroeconomic strategies and political institutions to work within existing communal structures and resource ownership. As a discipline, agroecology can potentially combine sociology, economics, agronomy, and ecology with a bottom-up approach (Addinsall et al., 2015).

25. Discussion

This is the first review to examine the state of data on progress and barriers towards achieving food security in Melanesia as defined by United Nations Sustainable Development Goal 2: Zero Hunger and its component targets. Globally, Indigenous Peoples makeup ~5% of the global population and are responsible for protecting ~80% of the world's biodiversity (Etchart, 2017). Indigenous Melanesians live within one of the most biodiverse regions in the world, however our findings suggest that traditional agrobiodiversity and food system knowledge are being lost to urbanization, lifestyle changes, imported foods, and deforestation. While progress has been made in reducing stunting and wasting, considerable efforts are still required to reverse the rising rates of NCDs and achieve food security in Melanesia. This discussion is organized by a food systems framework, including agri-food production and sales, trade and policy, diet patterns and consumer behavior, and health outcomes.

26. Agri-food production and sales

Our findings suggest that agrobiodiversity within Indigenous Melanesian food systems is declining, related to crop diseases and pests, climate change, deforestation, and industrially produced monocultured crops such as palm oil – all of which are disrupting traditional agri-food production and associated knowledge (Addinsall et al., 2015; Iramu et al., 2018; Koczberski et al., 2012; Mertz et al., 2012; Nichole and Charles, 2017; Thaman, 2014; Ticktin et al., 2018). It is well documented that agricultural biodiversity within food systems can support nutrient-rich diet patterns and livelihoods aimed at improving health outcomes, and buffer against the spread of pests and disease (Iramu et al., 2018; Zimmerer and Vanek, 2016). Additionally, the conservation of bees and associated ecosystem services are critically important yet understudied component of sustainable food systems and require additional research (Groom and Schwarz, 2011). Overall our findings indicate that agrobiodiversity trends are moving away from targets set by SDG 2.

Seafood is a critical and culturally important food for achieving food and nutrition security in Melanesia. Cold chain storage, though costly, is a proven effective strategy that can help improve the quality of perishable items such as seafood and other temperature sensitive agri-food products (Shah et al., 2018). FADs may provide a cost-effective solution for promoting increased seafood catches in the short term, supporting income generation and better nutrition (Albert et al., 2014). However, as global fish stocks are projected to decline, longer-term solutions such as aquaculture are required to ensure food and nutrition security (Hauge et al., 2009). Last, our findings indicate that produce marketplaces may not be safe, sanitary, accessible, or affordable for all agri-food sellers. In these instances, better transportation, storage, and safety are needed to improve market conditions and thus the food and nutrition security of Indigenous Melanesians (Nichole and Charles, 2017).

27. Trade and policy

Trade policies and agreements have substantially influenced food availability and quality in Melanesia, as evidenced by stakeholder interviews and country-level food import data. Micronesia and the broader Pacific have also experienced linkages between trade liberalization and a higher propensity for obesity (Cassels, 2006). Global trends reflect a similar connection between trade policies and diet quality, food environments, and obesity (Hawkes, 2006; Malik et al., 2013). There is a call for greater transparency in local food systems to ensure that policy is designed for public prioritise public health over profit (Thow et al., 2011).

28. Diet, food consumption, and consumer behavior

Despite efforts to improve health outcomes, NCDs such as T2DM, hypertension, and CVD continue to rise across Melanesia. Data from our review indicate urbanization is associated with reduced diet quality, food insecurity, and urban living environments that are less conducive to active lifestyles. Increased consumption of underutilized species have the potential to improve diet quality (Hunter et al., 2019). Green leafy vegetables and tender stems are rich in vitamins, folic acid, calcium, iron, and protein and have great potential to generate income for farmers, meet demand in urban markets, and to contribute to meeting UN sustainability goals (Nierenberg, 2018).. However, lack of space to cultivate one's own foods, the high cost of fruit and vegetables, and increased access to inexpensive energy-dense foods are likely drivers of reduced diet quality.

Our findings from Melanesia add to the growing consensus that nutrition education is a leading predictor of food consumption preferences and that even modest changes in behavior and diet patterns significantly increase obesity risk (Dancause et al., 2013; Devi et al., 2015; Frayon et al., 2017). Significant reductions in severe malnutrition were achieved through multifaceted intervention approaches that include nutrition education and integrate with existing healthcare and agricultural systems (Landi et al., 2017). Data also challenge the Western notion that excess body fat is perceived as unfavourable, an important consideration for developing culturally sensitive nutrition education and health promotion strategies.

29. Health outcomes

Despite efforts to improve health outcomes, NCDs, such as T2DM, high blood pressure, and CVD, continue to rise across Melanesia. Calculations extracted from FAO food balance sheets indicate several nutrient deficiencies across Melanesia, including vitamin B_2, vitamin A, calcium, iron, and zinc. Micronutrient deficiencies and overnutrition are symptoms of the nutrition transition and urbanization, trends which have been documented globally (Peng et al., 2020).

Microbial and genetic factors may help our understanding about how to prevent and reverse NCDs in a Pacific population. As Martínez et al. (2015) found, the higher gut microbial diversity found in Papua New Guinean populations may be protective against Western inflammatory diseases related to a higher intake of plant and fibre-rich foods in traditional cultures. Genetic polymorphisms may have been influenced by unique selection pressures in certain Pacific Islands populations, and a better understanding of the modality of such genotypes may mitigate the epidemic of non-communicable diseases in the Pacific Islands.

30. Limitations

Limitations of this review include a lack of comprehensive data examining food security trends in Melanesia over the past 10 years. Given the lack of published literature, this review could have been improved by systematically including grey literature and government reports within the results section, rather than only in the introduction and discussion. Melanesia, though geographically proximate, contains vast topographical differences, ranging from PNG highlands to low-lying Solomon Islands atolls. Findings are not always representative of Melanesia at large, nor of all its Indigenous peoples, due to immense diversity in cultures, food preferences, traditional knowledge, and belief systems. Rather, these findings are a proxy for trends, challenges, and opportunities. More studies are needed explicitly assessing linkages between agricultural production, consumption, health, and the environment.

31. Recommendations and strategies towards SDG 2

Numerous studies from in this review cited nutrition education as a low-cost, effective means to improve food and nutrition security for Melanesians. A recent technical report identified community food production initiatives in PSIDS as part of the solution for addressing the global syndemic by increasing dietary diversity and incomes while reducing household food expenditure (Iese et al., 2020). Common themes from successful nutrition education strategies to reduce NCD risk among Indigenous peoples include a dedicated focus on the Indigenous population, widespread community involvement and integration of local health workers, and a focus on high risk individuals (Huffman and Galloway, 2010). Future education strategies could be further integrated into schools, workplaces, and public health campaigns, and should embrace traditional, neglected, and underutilized species that are both culturally important and nutrient-rich (Johns and Eyzaguirre, 2006). Nutrient dense foods like dark leafy green vegetables are underutilized and rich in vitamins, folic acid, calcium, iron, and other essential nutrients. Traditional foods also have the potential to generate income for farmers, meet demand in urban markets, and contribute to meeting UN sustainability goals (Nierenberg, 2018).

Agrobiodiverse foods and their associated indigenous knowledge have been found to provide solutions towards sustainable diet patterns (Kahane et al., 2013). There is growing recognition that many high quality foods originate within indigenous food systems, and can bring significant benefits to the entire world (Kuhnlein et al., 2013). Studies have identified agroecological approaches informed by participatory research and indigenous knowledge can help empower communities and increase food sovereignty (Putnam et al., 2014). However, agrobiodiversity production, consumption and knowledge in Melanesia are fading (Kahane et al., 2013). Systematic assessments of agrobiodiversity within Melanesia are warranted. On-farm diversity could be integrated within monocultured industrial crop production (such as palm oil plantations) by planting traditional crops between oil palm trees (Koczberski et al., 2012). More research is needed to investigate opportunities to integrate traditional knowledge and crops within palm oil production for both food and economic security (Koczberski et al., 2012). Recommendations include education around seed saving and establishing community seed banks and plant collections. Equipped with such knowledge, farmers in this biodiversity hotspot may maintain their traditional plant heritage, diversify their diets, and improve their livelihoods (Iramu et al., 2018).

Canned fish can help fill the gap between sustainable coastal fish production and recommended fish intakes (Bell et al., 2019). This is particularly true for inland populations without regular access to oceans. However, as global fish stocks are projected to decline, longer-term solutions are required to ensure food and nutrition security. To ensure food and nutrition security, increased availability of diverse and affordable protein options are required, including seafood, small non-ruminant livestock, and plant-based sources of protein such as legumes. Increased diversification of protein can improve health outcomes by providing essential nutrients for both rural and urban Melanesians (Kahane et al., 2013). Canning, drying, and packaging diverse proteins can help improve access, affordability, and shelf-stable options of nutrient-dense foods. Value added foods using minimally processed value-added local foods can help enhance food and nutrition security while providing local economic opportunities (Augustin et al., 2016).

Barriers to evidence-based policy approaches include lack of technical knowledge and access to information and poor collaboration opportunities (Waqa et al., 2017). Trade policies should require additional monitoring and evaluation and explore which policies best counteract stark rises in unhealthy food imports.

Last, our findings suggest that participatory knowledge production is critical to building trust with Indigenous peoples. Barriers include cultural differences between Western science and traditional knowledge, a lack of trust between local communities and external scientists, inappropriate governance structures, and inadequate political and technical support. Trust, partnerships, and sustained efforts are required to apply adaptation science and improve resilience towards adverse impacts of climate change (Cvitanovic et al., 2016).

Melanesia will increasingly face challenges from the global syndemic, which will be magnified by growing and rapidly urbanizing populations, increased land and water pressures, environmental degradation, and the nutrition transition. To quantify and measure progress towards SDG 2: Zero Hunger, a comprehensive study across Melanesia focused on undernourishment and food insecurity is warranted. Future efforts should focus on promoting nutrition education, improved education for women, agrobiodiversity within food systems, sustainable seafood production, diversification of protein sources, equitable market opportunities, and crafting trade agreements with insights from public health professionals to encourage health over profits. Strong participatory strategies inclusive of traditional knowledge are essential if Melanesia aims to progress towards the targets outlined in SDG 2: Zero Hunger.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

SCOPUS DATABASE SEARCH

Search language = English.
Date: 22 JAN 2020
Publication year: < 10 years.
Top level databases: Life Sciences, Social Sciences, Health Sciences, General, Agricultural and biological sciences.
TITLE-ABS-KEY (“sustainable food*" OR “sustainable agricultur*" OR “sustainable diet*" OR nutrition* OR malnutrition* “zero hunger” OR “food security” OR agrobiodiversity OR “agricultur* biodiversity”) AND (melanesi* OR fiji* OR solomon* OR “new guinea*" OR vanuatu* OR “new Caledonia*") AND PUBYEAR > 2009 AND PUBYEAR < 2021.
Search language = English.

WEB OF SCIENCE DATABASES

Search language = English.
Date: 22 JAN 2020
Publication year: < 10 years.
Databases: WOS, BIOABS, CABI, CCC, FSTA, KJD, MEDLINE, RSCI, SCIELO.
(TI=(((“sustainable food*" OR “sustainable agricultur*" OR “sustainable diet*" OR nutrition* OR malnutrition* “zero hunger” OR “food security” OR agrobiodiversity OR “agricultur* biodiversity”) AND (melanesi* OR fiji* OR solomon* OR “new guinea*" OR vanuatu* OR “new Caledonia*"))

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Chapter 3: Indigenous Peoples' food systems: Insights on sustainability and resilience from the front line of climate change. From the ocean to the mountains: storytelling in the Pacific Islands.

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Purpose for inclusion: This chapter features two weeks' worth of data sources from participatory focus group discussions in the village of Baniata located in the Western Province of Solomon Islands, focused on food system resilience and sustainability in light of climate change.

Method Guidebook: The method guidebook for this chapter can be found in Appendix L.

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CHAPTER 4 | MELANESIANS[SI] PEOPLE'S FOOD SYSTEM | SOLOMON ISLANDS

CHAPTER 4

From the ocean to the mountains: storytelling in the Pacific Islands

Fishing and agroforestry food system of the Melanesians[SI] people in Solomon Islands

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Indigenous People's food system profiling in Baniata community, Solomon Islands.
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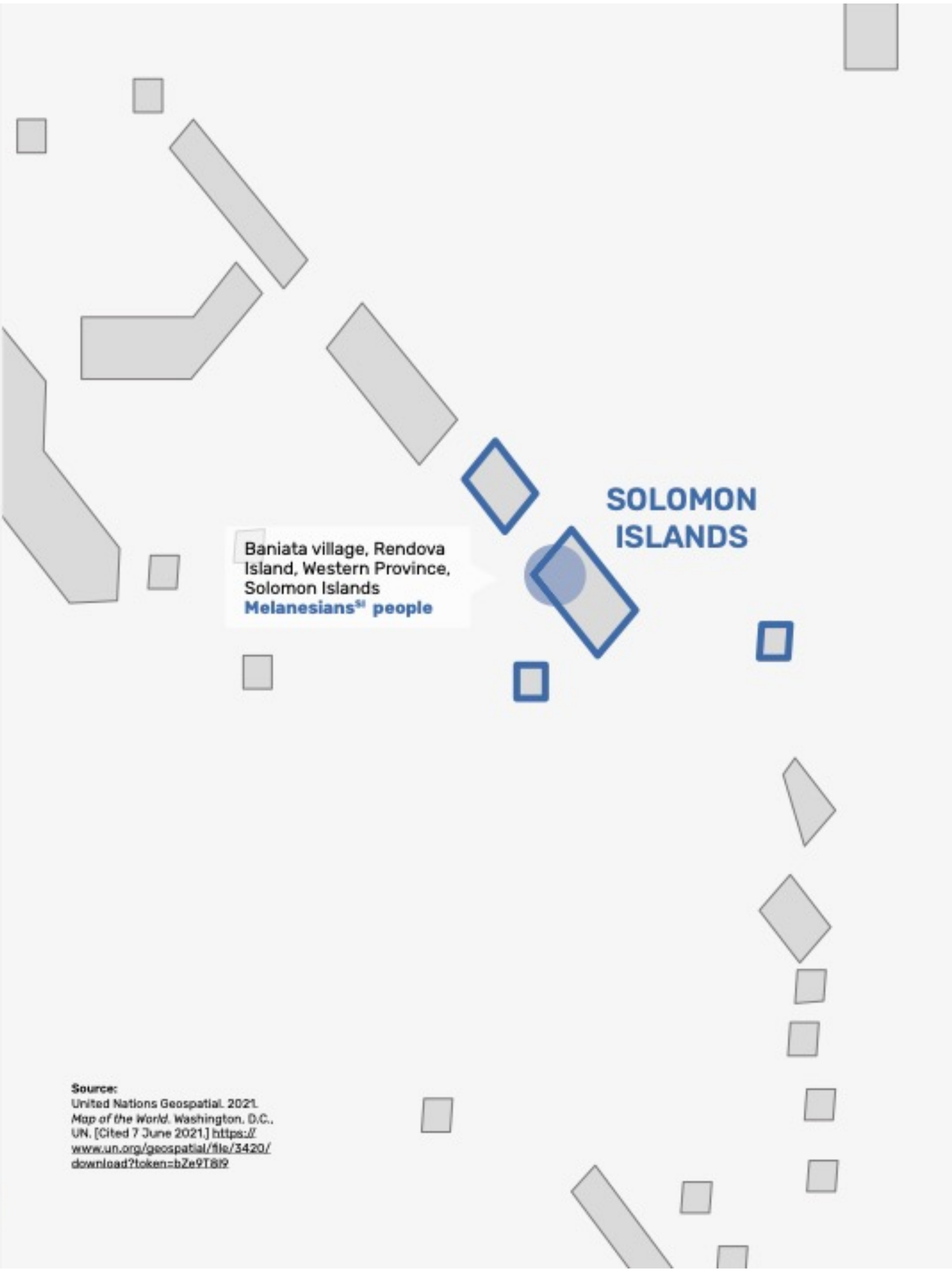

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*“We are a welcoming community that works together, and we are proud of our baked **ngali** nuts.”*

Woman from the community in Baniata.

AT A GLANCE

This study characterised the food system of the village of Baniata, on Rendova Island in the Western Province of Solomon Islands. The original land-owning tribe of Baniata was Irurego, but currently eight different tribes live amongst one another. The community is self-sufficient, with the majority of food production, 70 percent, by agroforestry farming, fishing, hunting and wild sourcing; however, an increasing percentage (30 percent) of their food is sourced from imported or processed foods from the market. Home foods are produced without agrochemical inputs, as villagers have expressed interest in maintaining organic production practices. All villagers rely on agri-food sale as their primary source of income including garden produce, copra (dried coconuts) and ***ngali*** nuts. Traditional foods are eaten daily in Baniata, often mixed with imported and highly processed foods. Food insecurity is perceived as a result of seasonal availability of home garden foods, impacts of pests and diseases on crops, changes in weather patterns and impacts on seas, high costs of food items such as meat and milk, and shifting taste preference from traditional crops to processed foods. Whilst the diversity of crops is declining, the local traditional varieties offer resilience against climate and pest disturbances, helping promote nutritious diets and access to diversified foods.

SECTION 1 COMMUNITY AND FOOD SYSTEM PROFILE

1. GEOGRAPHIC CONTEXT

Solomon Islands is a Melanesian archipelago of more than 600 000 people and more than 900 islands. Approximately 65 000 live in the capital Honiara on the island of Guadalcanal. The remaining Solomon Islanders reside in villages of varying size, spread across the other islands.

This research was conducted in the village of Baniata, in the Western Province on Rendova Island. Baniata, with a population of around 900, is a 90-minute petrol-powered boat ride from the nearest city and airport – Munda. Two smaller villages are within walking distance of Baniata: Havila, with a population of approximately 250, and Retavo, with a population of approximately 250. The three villages sit between steep mountain faces and the Solomon Sea. The climate of Solomon Islands is equatorial, characterised by heat and humidity, with distinctive wet and dry seasons. The temperature is consistently around 29 °C, with mild seasonal fluctuations, and rainfall varies amongst the islands, with the Western Province receiving the highest levels of approximately 3 000 mm per annum. Villages are surrounded by dense biodiverse bush, home to numerous native and endemic species.

2. LOCAL DEMOGRAPHICS AND SOCIAL ORGANIZATION

Villages typically contain one dominant tribe. The original land-owning tribe of Baniata was Irurego. However, with migration related to marriage, headhunting and religious practices, eight different tribes – constituting approximately 900 villagers – live amongst one another. Baniata consists primarily of Melanesians, however, a few Polynesians have married into the village.

Households usually consist of multigenerational families, who typically eat and spend leisure time together. Youths outnumber adults, and national data predicts a doubling of Solomon Islands' population over the next few decades.

The Solomon Islands archipelago is home to over 75 distinct languages. The official language is English, the common language across all the islands is Pidgin, and the local language in Baniata is Touo. Most villagers are able to speak multiple local languages, including those spoken on Rendova Island or across the Western Province. Despite English being the official language, it is only spoken by about 2 percent of the population. Children are not required by law to attend school. Most children in Baniata previously attended schools, as their parents raised enough money through selling agri-food products to pay fees.

Religion is a significant part of daily life in Baniata. Two primary religions are practised in Baniata: Christian Fellowship Church (CFC) and Seventh-day Adventist Church (SDA). The two religious communities live next to each other in Baniata; however, there is a physical boundary, a planted hedge, that separates the two sides. The Christian Fellowship Church makes up the largest proportion of village residents (approximately 70 percent). Seventh-day Adventist Church followers are prohibited from consuming crustaceans, pork, possums, crocodiles, molluscs and turtles. They are also prohibited from drinking alcohol, tea, coffee, smoking tobacco, or consuming betel nut (*Areca catechu* L., Areaceae) – a commonly chewed sedative drug in Solomon Islands. The age of marriage varies, but typically occurs when the men and women are around 25-30 years old. In order for men to prove they are ready to marry, they must be capable of building a house and lighting a fire using a stick. For women to prove they are ready for marriage, they must cook using a ***motu*** (earth oven) and weave a basket.

Baniata has a diverse mosaic landscape made up of seven primary methods of land use. These include village settlements; mountain ranges; the sea, rivers and streams; food gardens; agroforestry (***ngali*** nut trees, (*Canarium indicum* L.)); and coconut plantations.

3. LOCAL FOOD PRODUCTION

Baniata has over 127 food-providing species available for production, raising, collection from the wild, and ultimately consumption. Production systems include coconut plantations, food gardens, agroforestry systems, small amounts of domesticated livestock that are free-roaming chickens, hunting, fishing, and wild food harvesting. Homegrown foods are produced without agrochemical inputs, as villagers have expressed interest in maintaining organic production practices. However, pests and diseases are increasing in impact and severity. Food waste and animal manure are not typically recycled back into food production systems. Local production coupled with wild food collection has been the primary source of dietary energy for centuries.

Crops

Home gardens produce roots, tubers, bananas, vegetables and fruits. Crop rotations and intercropping techniques are often practised. ***Ngali*** nut trees (*Canarium indicum*) are reported to be a significant source of both nutrition and income. Since domestication, they are planted with companion crops such as ***karuvera*** (*Xanthosoma sagittifolium*, Chinese taro), yams, bean and shade-tolerant cassava. In total, 19 different crops are intercropped with ***ngali*** nut agroforestry. The nuts are also a primary source of food for ***ghausu*** (doves), which are raised as a food source for the villagers. Coconut is planted along the shoreline of the village and used for agri-food sales, as well as consumption in forms of coconut milk and water.

FIGURE 4.1. Landscape of Baniata and surrounding villages of Havila and Retavo

Source: Google Earth, 2018, modified by Chris Vogliano from Baniata community mapping exercises, 2021.

TABLE 4.1. List of cultivated foods: crops, planted trees and other cultivated foods

Group	Local name	Scientific name	English name
Condiments, seasonings, snacks and sweeteners	***tuva migori***	*Zingiber officinale* Roscoe, Zingiberaceae	Ginger
	aro migori	*Zingiber officinale* var. *rubrum* Theilade, Zingiberaceae	Ginger
Fruits and juices	***pineapple***	*Ananas comosus* (L.) Merr., Bromeliaceae	Pineapple
	soursop or omo	*Annona muricata* L., Annonaceae	Soursop
	me'u*	*Artocarpus altilis* (Parkinson) Fosberg, Moraceae	Breadfruit
	starfruit	*Averrhoa carambola* L., Oxalidaceae	Carambola
	fetu	*Bruguiera gymnorhiza* (L.) Savigny, Rhizophoraceae	Mangrove fruit
	pawpaw	*Carica papaya* L., Caricaceae	Pawpaw or papaya
	melon	*Citrullus lanatus* (Thunb.) Matsum. & Nakai, Cucurbitaceae	Watermelon
	half orange	*Citrus x aurantium* L., Rutaceae	Sour orange
	pomolo	*Citrus grandis* (L.) Osbeck, Rutaceae	Pomelo
	madarin	*Citrus reticulata* Blanco, Rutaceae	Mandarin
	sweet orange	*Citrus sinensis* (L.) Osbeck, Rutaceae	Orange
	mango	*Mangifera indica* L., Anacardiaceae	Mango
	multiple cultivars*	*Musa* sp., Musaceae	Banana (cooking)
	several cultivars	*Musa* sp., Musaceae	Banana (desert)
	rambutan	*Nephelium lappaceum* L., Sapindaceae	Rambutan
	avocado	*Persea americana* Mill., Lauraceae	Avocado
	gema fruit	*Pometia pinnata* J.R.Forst. & G.Forst., Sapindaceae	Pacific lychee
	guava	*Psidium guajava* L., Myrtaceae	Guava
	encori or ***opiti***	*Spondias dulcis* Soland. Ex Frost. fil., Anacardiaceae	Golden apple
	kapicala	*Syzygium aqueum* (Burm.f.) Alston, Myrtaceae	Watery rose apple
	kapicala	*Syzygium malaccense* (L.) Merr. & L.M.Perry, Myrtaceae	Malay apple
Nuts and seeds	***voze voze****	*Barringtonia edulis* Seem., Lecythidaceae	Cut nut
	anire tinge*; cut nut* (several varieties)	*Barringtonia novae-hibernae* Lauterb., Lecythidaceae	Cut nut
	tinge*	*Barringtonia procera* (Miers) R. Knuth, Lecythidaceae	Cut nut
	reef nut	*Canarium harveyi* Seem., Burseraceae	Canarium nut
	gasio (black nut)	*Canarium indicum* L., Burseraceae	Canarium nut
	ngali nut*	*Canarium indicum* L., Burseraceae	Java or canarium nut
	ngali nut*	*Canarium solomonense* B.L.Burtt, Burseraceae	Canarium nut
	coconut*	*Cocos nucifera* L., Arecaceae	Coconut
Pulses	***peanut***	*Arachis hypogaea* L., Fabaceae	Peanut
	waku bean	*Benincasa hispida* (Thunb.) Cogn., Cucurbitaceae	Wax gourd
	butterfly bean	*Psophocarpus tetragonolobus* (L.) DC., Fabaceae	Wing bean
	snakebean* (cocoa)	*Trichosanthes cucumerina* L., Cucurbitaceae	Snake gourd
	snakebean*	*Trichosanthes cucumerina* subsp. *anguina* (L.) Haines, Cucurbitaceae	Snake gourd

TABLE 4.1. List of cultivated foods: crops, planted trees and other cultivated foods

Group	Local name	Scientific name	English name
Pulses	***cowpea bean***	*Vigna unguiculata* (L.) Walp. var. *unguiculata,* Fabaceae	Cowpea or dwarf bean
	bean (several varieties)	*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdc, Fabaceae	Yardlong bean
Starches (roots and tubers)	***ozo****	*Alocasia macrorrhizos* (L.) G.Don, Araceae	Giant taro
	fivo or buini; mahio; ruta; sisiri; sofu (various varieties)	*Colocasia esculenta* (L.) Schott, Araceae	Taro
	kakake	*Cyrtosperma merkusii* (Hassk.) Schott., Araceae	Swamp taro
	yam*	*Dioscorea alata* L., Dioscoreaceae *Dioscorea* sp. L., Dioscoreaceae	Greater yam
	vanuatu*	*Dioscorea cayenensis* subsp. *rotundata* (Poir.) J.Miège, Dioscoreaceae	Greater yam
	pana	*Dioscorea esculenta* (Lour.) Burkill, Dioscoreaceae	Pana or lesser yam
	bou*	*Dioscorea* sp. L., Dioscoreaceae	Pana or lesser yam
	kumara*	*Ipomoea batatas* (L.) Lam., Convolvulaceae	Sweet potato
	various varieties	*Manihot esculenta* Crantz, Euphorbiaceae	Cassava
	karuvera	*Xanthosoma sagittifolium* (L.) Schott, Araceae	Chinese taro
Vegetables	***slippery cabbage****	*Abelmoschus manihot* (L.) Medik., Malvaceae	Slippery cabbage
	shallot	*Allium cepa* var. *aggregatum* G.Don., Amaryllidaceae	Spring onion or bunching onion
	saladia	*Brassica campestris* L., Brassicaceae	Saladeer
	paksoi; choy sum	*Brassica rapa* subsp. *oleifera* (DC.) Metzg., Brassicaceae	Chinese cabbage
	cucumber	*Cucumis sativus* L., Cucurbitaceae	Cucumber
	pumpkin leaves	*Cucurbita maxima* Duchesne, Cucurbitaceae	Pumpkin leaves
	kankung	*Ipomoea aquatica* Forssk., Convolvulaceae	Kang kong
	watercress	*Nasturtium officinale* W.T. Aiton, Brassicaceae	Watercress
	bonio	*Sauropus androgynus* (L.) Merr, Phyllanthaceae	Sweet leaf
	eggplant	*Solanum melongena* L., Solanaceae	Eggplant
	karuvera* leaves	*Xanthosoma sagittifolium* (L.) Schott, Araceae	Chinese taro leaves
	corn	*Zea mays* L., Poaceae	Maize

*Species present in the ***ngali*** nut agroforestry system

Solomon Islands family standing near their home and personal garden in Baniata Village.

Livestock

Livestock in Baniata was previously more productive, with chickens and pigs raised in fenced areas, but now primarily consists of free-roaming chickens and a few domesticated pigs. The featherless neck chicken breed, which has an increased tolerance to heat, was introduced in 2016. It is not uncommon that men catch young wild pigs and raise them until they have grown large enough for slaughter. During 1975–1980, cattle grazed in the community. This is no longer practised due to cattle spoiling gardens, as well as a lack of expertise required to raise the animals. Chickens are raised both for their eggs and meat. Non-seafood-animal-sourced foods are consumed once a month or less, and reserved for special occasions such as birthdays, marriages, Christmas and New Year's. All animals are processed and consumed within the community. No meat conservation techniques were reported. Main forage and feed for livestock include coconut leaves and waste, and food scraps. Less frequently, ***hote*** (white ants) collected from the bush are given to chickens, as well as cassava leaves from the home gardens.

TABLE 4.2. List of livestock

Group	Local name	Scientific name	English name
Birds and poultry	***chicken*** (whiteman)	*Gallus gallus domesticus* L., Phasianidae	Chicken
	naked neck chicken (featherless neck)	*Gallus gallus domesticus* L., Phasianidae	Chicken
Mammals	***pig*** (crossbreed)	*Sus scrofa domesticus* Erxleben, Suidae	Pig

Fishing

Fishing is primarily the role of men, however, women are able to fish if desired. Open seas are a source of tuna and reefs are the source of numerous varieties of coastal fish. To catch fish, a rope is crafted from the inner bark of a ***pusi*** tree. The bark of this tree is flexible and can be easily tied to a bamboo pole with a traditional hook known as a ***zuahango***. Occasionally villagers will use a poisonous plant, ***buna*** or ***deris***, as bait to kill fish. The community has motorboats to go further out to sea, and members use nets and modern fishing lines with hooks. Traditional knowledge guides fishing: full moon is the best time for catching ***ghohi*** (*Sphyraena barracuda*, barracuda) and ***mara*** (*Caranx* spp., trevally); new moon, especially from the first to the fourth day, and on the seventh day, is best for fishing generally; and June and July are the best months to catch Kingfish.

The primary seafood caught is ***bonito*** (*Katsuwonus pelamis*, skipjack tuna), turtles, sharks and eels; however, over 51 different aquatic species were fished locally. Villagers are able to keep any size of fish caught. Fish is consumed fresh, with only a few villagers smoking fish for preservation. Fish and eels are declining due to increased populations of villages, higher pressure on the resources, and increased flooding, which washes eels out to sea. Fishing is restricted for multiple days directly following the death of a villager.

TABLE 4.3. List of wildlife used as food: fish, molluscs and crustaceans

Group	Local name	Scientific name	English name
Fish	***asirae***	*Acanthurus gahhm* Forsskål, Acanthuridae	Brown tang (surgeon fish)
	bireke	*Acanthurus lineatus* L., Acanthuridae	Lined surgeon fish
	evaeva	*Acanthurus nigricauda* Duncker & Mohr, Acanthuridae	Epaulette surgeonfish
	tavazi	*Acanthurus xanthopterus* Valenciennes, Acanthuridae	Yellow fin surgeon fish
	eelfish	*Anguilla marmorata* Quoy & Gaimard, Anguillidae	Giant mottled eel
	fubua	Balistidae sp.	Triggerfish
	makoto	*Balistoides viridescens* Block & Schneider, Balistidae	Titan triggerfish
	topa	*Bolbometopon muricatum* Valenciennes, Scaridae	Humphead parrot fish
	mamula	*Caranx* spp. Lacépède, Carangidae	Trevally
	rainbow or babalu	*Elagatis bipinnulata* Quoy & Gaimard, Carangidae	Rainbow runner
	eoea	*Encrasicholina punctifer* Fowler, Engraulidae	Buccaneer anchovy
	orufu	*Epinephelus hexagonatus* Forster, Serranidae	Starspotted grouper
	zoata	*Epinephelus lanceolatus* Bloch, Serranidae	Giant grouper
	bukulu	*Epinephelus* spp. Bloch, Serranidae	Round head grouper
	noto	*Etelis* spp. Cuvier, Lutjanidae	Deep water snapper
	sogari	*Gazza achlamys* Jordan & Starks, Leiognathidae	Smalltoothed ponyfish
	zaoto	*Halichoeres argus* Bloch & Schneider, Labridae	Angus wrasse
	viviru	Istiophoridae sp.	Marlin
	bonito	*Katsuwonus pelamis* L., Scombridae	Skipjack tuna

TABLE 4.3. List of wildlife used as food: fish, molluscs and crustaceans

Group	Local name	Scientific name	English name
Fish	***hegosune***	*Kuhlia marginata* Cuvier, Kuhliidae	Dark-margined flagtail (river fish)
	mihu	*Lethrinus miniatus* Forster, Lethrinidae	Sweetlip emperor
	fufu	*Myripristis* spp., Holocentridae	Soldier fish
	fagu	*Naso brevirostris* Cuvier, Acanthuridae	Canvass or unicorn fish
	begozo	*Philypnodon grandiceps* Krefft, Eleotridae	Olive flat head gudgeon
	fehu	*Plectorhinchus lineatus* L., Haemulidae	Yellowbanded sweetlips
	embo	*Pseudomyxus capensis* Valenciennes, Mugilidae	Freshwater mullet
	katukatu	*Sardinella* spp. Valenciennes, Clupeidae	Sardine
	heta	*Sargocentron tiereoides* Bleeker, Holocentridae	Pink squirrel fish
	sioura	*Scarus* spp. Forsskål, Scaridae	Parrot fish
	eusava, lasilasi	*Scomberoides lysan* Forsskål, Carangidae	Doublespotted queenfish
	kingfish	*Scomberomorus cavalla* Cuvier, Scombridae	Spanish mackerel
	shark	Selachimorpha spp.	Shark
	gore	*Siganus corallinus* Valenciennes, Siganidae	Blue-spotted spinefoot (yellow reef fish)
	sirusiru	*Siganus lineatus* Valenciennes, Siganidae	Golden-lined spinefoot
	gohi	*Sphyraena barracuda* Edwards, Sphyraenidae	Pinkhandle or obtuse barracuda
	tatalingi	*Thunnus albacares* Bonnaterre, Scombridae	Yellowfin tuna
	vavanaka	*Toxotes jaculatrix* Pallas, Toxotidae	Archer fish
	dalo	*Trachinotus baillonii* Lacepède, Carangidae	Small spotted dart
	somasoma	*Tylosurus crocodilus* Péron & Lesueur, Belonidae	Houndfish or needlefish
Molluscs and crustaceans	***deo***	*Anadara antiquata* L., Arcidae	Antique ark (bivalve)
	kenekene	*Atactodea striata* Gmelin, Mesodesmatidae	Striate beach clam
	coconut crab	*Birgus latro* L., Diogenidae	Coconut crab
	crayfish	*Cambarus* spp. Erichson, Cambaridae	Freshwater lobster
	ropi	*Cerithidea quadrata* G. B. Sowerby II Sowerby, Potamididae	Black chut-chut
	prawn	*Macrobrachium lar* J.C.Fabricius, Palaemonidae	Prawn
	octopus	*Octopus cyanea* Gray, Octopodidae	Octopus
	riki	*Pinctada margaritifera* L., Pteriidae	Oyster
	kapehe	*Scylla serrata* Forskål, Portunidae	Mud crab
	squid	*Sepioteuthis lessoniana* d'Orbigny, Loliginidae	Reef squid
Reptiles	***sea turtle***	*Chelonia mydas* L., Cheloniidae	Green sea turtle
	turtle	*Dermochelys coriacea* Vandelli, Dermochelyidae	Leatherback turtle

TABLE 4.4. List of wild eggs from marine animals used as food

Group	Local name	Scientific name
Eggs	***coconut crab***	*Birgus latro* L., Diogenidae
	turtle	*Chelonia mydas* L., Cheloniidae
	leathback turtle	*Dermochelys coriacea* Vandelli, Dermochelyidae
	crayfish	*Panulirus penicillatus* Olivier, Palinuridae
	fish	Unidentified

Hunting and trapping

Wild game is hunted in lowland forests and mountain ranges beyond the village. Spears, bows and arrows are used. Hunting is still common, although declining due to less interest from the youth. Primarily men and boys hunt, however, women will accompany them to help carry the food and spears, and bring the kill back to the village. Elders lead the youth on the hunting trail, which provides an opportunity to share traditional knowledge including uses of local plants, hunting and fishing techniques, and traditional songs.

Wild boars are hunted for celebrations and are sometimes sold at the market. They are targeted if they destroy gardens or eat ***ngali*** nuts from the forest floor. Wild boar hunting techniques include the use of spears, traps and domesticated dogs (up to five at once). Other wild species hunted in the bush include parrots, ***bias*** (red nose bird), flying foxes (bats) and possums. These are typically caught with slingshots or bows and arrows. Fresh water invertebrates are also collected for consumption.

TABLE 4.5. List of wildlife used as food: birds and mammals

Group	Local name	Scientific name	English name
Birds and poultry	***duck***	*Anas superciliosa* Gmelin, Anatidae	duck
	kurukuru	*Ducula rubricera* Bonaparte, Columbidae	red knobbed fruit pigeon
	hou	*Egretta sacra* Gmelin, Ardeidae	pacific reef heron
	belama	*Fregata minor* Gmelin, Fregatidae	great frigate bird
	helekai	*Larus* spp. L., Laridae	seagull
	red nose bird or ***bichere***	*Porphyrio porphyrio* L., Rallidae	purple swamphen
	parrot	Psittaciformes spp.	parrot
	hornbill	*Rhyticeros plicatus* J. R. Forster, Bucerotidae	hornbill
Mammals	***possum***	Phalangeriformes sp.	possum
	flying fox	*Pteropus vampyrus* L., Pteropodidae	flying fox
	pig (wild)	*Sus scrofa* L., Suidae	wild boar

TABLE 4.6. List of eggs from wildlife used as food

Group	Local name	Scientific name
Eggs	***duck***	*Anas superciliosa* Gmelin, Anatidae
	dove	*Ducula pistrinaria* Bonaparte, Columbidae
	dove	*Ducula rubricera* Bonaparte, Columbidae
	megapode	*Megapodius eremita* Hartlaub, Megapodiidae
	rednose bird	*Porphyrio porphyrio* L., Rallidae
	punder	Unidentified

Wild edibles

Wild harvesting of plants is a tradition in Baniata. Edible plants and fruit were previously a regular source of food, but the frequency and amount of wild foods harvested has declined over the previous three to four decades. However, wild foods are more heavily relied on when villagers are harvesting ***ngali*** nuts, camping away from the village, or during times of travel. Few wild foods are sold for income generation.

Starchy foods collected include wild yam, wild taro and wild breadfruit. Wild foods collected for consumption include green leafy vegetables such as ferns. Fruits harvested from the wild include ***voh***, ***gima***, ***sohvao*** and wild mangos. ***Voh*** is a sweet and juicy yellow flesh fruit, and is said to cause itchiness. Its season coincides with the ***ngali*** nut harvesting season, and it is often consumed during the collection of the nuts. Other wild foods include ***ivi*** (*Inocarpus fagifer*, Tahitian chestnut) and a ***gavu*** (*Gnetum gnemon*, tulip nut).

TABLE 4.7. List of wild edibles

Group	Local name	Scientific name	English name/ Variety
Fruits and juices	***me'u****	*Artocarpus altilis* (Parkinson) Fosberg, Moraceae	Breadfruit
	sohvao	*Burckella obovata* (G.Forst.) Pierre, Sapotaceae	Burckella
	gavu	*Gnetum gnemon* L., Gnetaceae	Tulip nut
	ivi*	*Inocarpus fagifer* (Parkinson) Fosberg, Fabaceae	Tahitian chestnut
	mango	*Mangifera indica* L., Anacardiaceae	Mango
	kapicala	*Syzygium malaccense* (L.) Merr. & L.M.Perry, Myrtaceae	Malay apple
	voh	Unidentified	Unidentified
	gima	Unidentified	Unidentifed
Seaweed	***seaweed***	*Caulerpa lentillifera* J. Ag., Caulerpaceae	Sea grapes
Vegetables (leaves)	***savita***	*Alsophila hornei* Baker, Cyatheaceae	Fern
	atiefao; faro; omu	*Colocasia esculenta* (L.) Schott, Araceae	Taro leaves
	puha	*Diplazium esculentum* (Retz.) Sw., Athyriaceae	Fern
	fengo; unofengo	*Diplazium* spp., Athyriaceae	Fern
	inomahi*	*Ficus copiosa* (Roxb.) Steud., Moraceae	Sandpaper cabbage or plentiful fig
	wagozo (several varies)	*Polyscias fruticosa* (L.) Harms, Araliaceae	Bebero or geke or tagala
	wagozo	*Polyscias verticillata* Stone, Araliaceae	Bebero or geke or tagala

TABLE 4.7. List of wild edibles

Group	Local name	Scientific name	English name/ Variety
Vegetables (leaves)	***rosi***	*Stenochlaena palustris* (Burm.f.) Bedd, Blechnaceae	Fern
	bie	Unidentified	Unidentified

*Species present in the ***ngali*** nut agroforestry system

4. OTHER LAND-BASED PRODUCTIVE ACTIVITIES

Many wild plants have non-food uses, including clothing, construction, bags, medicine, fuel and bedding. Wild timber is used for house and other structure construction. Firewood is typically harvested from wild ***vasa*** (*Vitex cofassus* Reinw. ex Blume, Lamiaceae, deuru) and ***gema*** (*Pometia pinnata*, Pacific lychee) trees. Chainsaws are now used, and have improved the efficiency of collecting wood. There has been no attempt to domesticate tree species for timber. Trees standing in or around taboo sites are restricted for use for any purpose. Raw materials sourced from the landscape are not directly sold to the market; however, crafted products such as baskets and bedding mats are made for home use, sale or trade.

Commonly used resources for clothing include pandanus, ***vusai*** and abalolo trees; construction materials come from sago palm, ***vasa, goliti, gema, vaho, loiacane*** and betel nut*[21] trunks; bags are made from coconut* fronds, ***gava***, pandanus and sugar trees; medicines include coconut, ***alite**** (*Terminalia catappa* L., Combretaceae), ***capica*** and ***ngali*** nuts; energy and fuel include any woods, ***vasa***, rai tree, coconut fronds, coconut husk and ***ngali*** nut shells; and beddings (mats) are made from pandanus and coconut fronds.

5. LOCAL CALENDAR

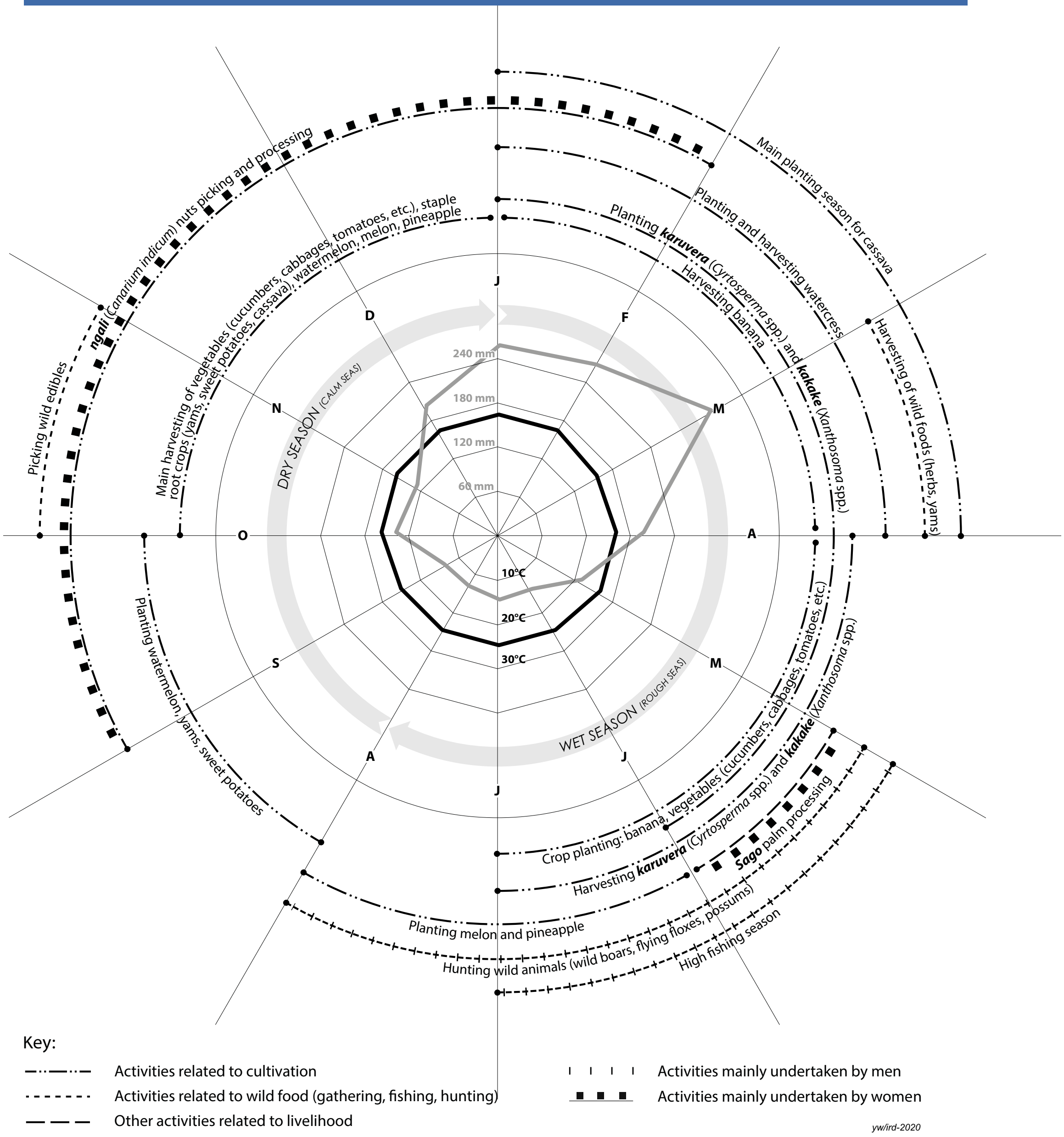
Villagers follow the 12-month Gregorian calendar and rely on nature's cycles to guide activities. For example, seven days after the new moon is best for fishing, as the fish – particularly reef snapper – are said to contain a higher content of oils. Certain crops are planted during either the full or new moon. Bananas planted during the season of high tides, caused by the gravitational pull of the moon, are believed to have the best harvests.

The temperature remains relatively stable throughout the year, and is 29 °C on average. However, there are variations in precipitation levels and slight variations in temperature. The two distinct seasons are dry and wet. The first seven months of the calendar year, from January to July, are the wet season, and the last five months, from August to December, are the dry season. Weather pattern changes bring varying intensities of storms and roughness of the seas. Rough seas can happen anytime of the year, but tend to concentrate between April and September. October through December have typically calmer seas, coinciding with lesser rainfall. Stronger winds and cyclones occur from January to March.

Crop plantings vary per season and rainfall. Cassava is preferably planted during the rainier weather from January to March, although it can be planted and harvested anytime throughout the year. During this time, watercress and bananas are harvested. In April, cucumbers, cabbage, bananas and taro are planted. Foods harvested and hunted during this season include ***sago*** palm, wild boars, flying foxes and possums. From August to October, watermelon, ***pana***, yams and ***kumara*** (sweet potatoes) are planted. At the beginning of this season, potatoes are typically harvested. Crops such as cabbages and cucumber are planted and harvested throughout the year but the main harvesting time for crops such as yam, pana and kumara is from October to December. It is also the season for ***ngali*** nut harvesting, however, the season has been more recently extended until February.

[21] *Species present in the ***ngali*** nut agroforestry system.

FIGURE 4.2. Average annual rainfall (mm) and temperature (°C) in Honiara, Solomon Islands, and seasonal activities by the Baniata villagers (elaborated by Yanto Wahyantono, IRD, 2020)



(These are available annual rainfall and temperature data in Honiara, the capital of Solomon Islands. Although following overall the same pattern, the rainfall profile may slightly differ from the one in Baniata village.)


Processing *ngali* nut.

Villagers can predict the onset of a cyclone by noting a ring of cloud around the moon at night, signaling that a cyclone or bad weather will hit in three to four days. Additionally, villagers take note of the quantity of ***ngali*** nuts that fall to the ground to determine the strength of winds. Typically, bad weather lasts either four or eight days. Rainbows are indicative of fine weather, as are particular birdsongs.

6. MARKET SOURCING AND TRADE

Munda is the primary town where villagers source foods from outside of the community. It is a 90-minute petrol-powered boat ride from Baniata, with a large wet market and multiple convenience shops. The Munda wet market provides a wide range of local food products including fish. Located near the Munda market are shops, which provide a range of processed foods, including sugar, oils and frozen desserts. These shops also sell household goods and supplies. Baniata has a small canteen that resells packaged foods sourced from Munda at a higher cost. Few items are sold here beyond canned tuna, sugar, rice, confectionaries, cigarettes and snacks. Foods purchased from markets and shops also include ferns, seaweed, shells especially mussels, reef fish, bananas, salt, noodles, flour, biscuits, bread, chocolate powder and butter. Non-food items include soap, kitchen utensils, clothes, knives, cups, plates, pots, carpet, diapers, garden hoe, kerosene, cutlery, cookware, rugs, nails, hammer, basket, axe, seeds, paddles, woven mats and local newspapers.

Traditionally, villagers would give foods to neighbours and friends. This now typically happens only for special occasions as a gift, such as for a birthday or wedding. Gifted foods include slippery cabbage, ***kumara*** (sweet potato), cassava, coconut or prepared dishes such as ***masi masi*** or local "puddings" made from starchy sago palm mixed with fresh ***ingi rusa*** (coconut).

Bartering and exchanges are commonplace. Bartering usually happens when villagers do not earn enough money or face financial challenges. These challenges occur more frequently during the lean season between April and July. Exchanges happen within Baniata, as well as with neighbouring villages. Common exchanges include sweet potatoes for fish; baked ***ngali*** nuts for kitchen utensils; sweet potatoes for mussels (two heaps for two heaps); ***ngali*** nuts for traditional weaved mats (5 kg of ***ngali*** nuts for three mats); ***sago*** palm starch for rice; ***ngali*** nuts for mattresses; and ***ngali*** nuts for plateware.

There are challenges to accessing and selling at the Munda market. The transport costs are high due to petrol prices, and foods often perish in transit and during sale at the market due to the lack of cold storage or refrigeration. Rough seas can limit villagers' ability to access the markets, adding another barrier to selling agri-food products. Certain women struggle to reach the market at all, as some husbands will not allow their wives to travel to Munda alone.

7. COMMUNITY HISTORY AND FOOD SYSTEM TRANSITIONS

Baniata was established as a village in the early 1800s, as a result of multiple numerous smaller villages of different tribes coming together. Up until a century ago, Baniata was almost completely self-sufficient, with community members relying mostly on homegrown and wild foods such as yams, bananas, taro, wild boars, possums and seafood. The arrival of the missionaries in 1915 led to the introduction of new foods including sweet potatoes and cassava, and the establishment of commercial coconut plantations. Seventh Day Adventist Church (SDA) arrived around 1920, influencing food production and consumption, including dietary exclusion of pigs, possums, eels and crustaceans.

The Second World War in 1941 catalysed further changes with the introduction of rice, canned meats, refined sugar and flour products, which were part of the American military rations. At the end of the war, these products were handed out to villagers, who developed a preference for these new foods that were high in salt, fat and sugar. Rice provided a quick and tasty alternative to traditional tubers that took significant time to process and prepare.

The destruction caused by cyclone Isa in 1950 was unprecedented, destroying coastal areas, including the coral reefs, which negatively impacted the availability of aquatic animals. The cyclone also led to the heavy flooding that destroyed many homes and gardens, ruining that season's harvest, and making the land difficult to cultivate thereafter due to the salinity of the flood water. This resulted in many households deciding to re-establish their home gardens far away from the coast, at the base or even up into the hills as a preventive measure. The migration of food gardens has been further influenced by the government subsidies in the 1970s encouraging coconut plantations, which were placed near Baniata's beach areas. As a result, the travel distance to tend to and collect food became a burden that fell on women and children. This practice continued until the 1980s, when additional expansion was no longer feasible due to lack of available suitable land.

Before the 1960s, Baniata was considerably smaller with fewer homes, and gardens close to each villager's home. Forests were also cleared to make room for expanding gardens, much further away from homes due to the increasing population of Baniata. In the 1990s, the logging destroyed much of the local forests within the greater mountain landscape. Since the early 2000s, Baniata has experienced an increase in population and a decrease in production yields, resulting in less local food for consumption and sale. Inexpensive and convenient imported food such as noodles and rice are replacing traditional foods such as root vegetables and bananas. An earthquake hit in 2007, causing a tsunami in Baniata, destroying home gardens, coastal houses and canoes that were needed to fish. This caused a period of food insecurity, during which villagers turned to externally produced and imported staple foods until the local production systems were able to recover.

SECTION 2
SUSTAINABILITY OF THE INDIGENOUS PEOPLE'S FOOD SYSTEM

1. PROVISION OF LIVELIHOODS, EQUITY AND SOCIAL WELL-BEING

Adequacy of income opportunities

All villagers in Baniata rely on agri-food sale as their primary source of income. Outlets include local markets, as well as regional and national sales of specific agri-food products such as dried coconut and ***ngali*** nuts. Fortnightly incomes range from less than SBD 100 to over SBD 1 000[22] depending on the season, market prices for commodity crops, in particular copra, and agri-food sales at markets.

The Munda market provides 50 percent of market income, which includes homegrown produce and prepared foods. Occasionally villagers will sell at the Sombara market near Munda, or the Noro market more rarely. Roughly 30 percent of income is from regional sales, including the sale of copra; 20 percent from the sale of ***ngali*** nuts and betel nuts in Honiara; and 2 percent from international markets, mostly from selling ***ngali*** nuts to New Caledonia.

[22] Equivalent to USD 12.4-124. Applying the UN Operational Rate of Exchange of 1 July 2018 (1 USD = 8.045 SBD). This rate will apply throughout the entire chapter.

Copra is the primary source of income for most of the villagers, which they sell throughout the year. Coconuts are transformed into copra through the process of drying with a slow-burning fire in a grass hut near the collection sites. It is exported via boats to regional resellers in Munda and Noro, who then sell in international markets. When the buying price of copra is high, villagers can receive SBD 5 000[23] per 100 kg. When it is low, they only receive SBD 1 000[24] per 100 kg. National and international markets dictate the prices. ***Ngali*** nuts are becoming an important source of income, in local and international markets, in particular New Caledonia, although they are also consumed at the household level. ***Ngali*** nuts are shelled, baked and dried by women and sold at local markets for SBD 35[25]/kg. Community members also sell ***masi masi*** prepared from slippery cabbage and ***ngali*** nuts for SBD 10[26] per piece. ***Ngali*** nuts are ground in a bowl, spread between layers of the slippery cabbage, and then cooked in a stone oven. The community is working towards achieving organic certification for the ***ngali*** nut. A dedicated processing facility is currently being constructed in the village, which will ensure the product is Hazard Analysis and Critical Control Point (HACCP) certified for food safety. After the organic and HACCP certifications are complete, the community will likely be able to expand to other international markets and increase sales.

Marketing of farmed food and vegetables is the second most common source of income. On market days, villagers can receive anywhere from SBD 100 to SBD 1 000[27] per trip. The most commonly sold foods are eggplant, tomato, capsicum, ***fiji vahu*** (a variety of sweet banana), cooking banana, cassava, slippery cabbage, watercress, ***paksoi*** (Chinese cabbage), sweet potato, yam, ***pana*** and fish. Betel nut, whilst not a food, is also commonly traded at the markets.

[23] Equivalent to USD 622.
[24] Equivalent to USD 124.
[25] Equivalent to USD 4.4.
[26] Equivalent to USD 1.24.
[27] Equivalent to from USD 12.4 to USD 124.


Young Solomon Island boy examining his father's daily fish catch.

© Massey University/ Chris Vogliano.

Availability is seasonal. Slippery cabbage and cassava, unlike many other foods, are available almost all year round. December has the most diversity and quantity of foods, whilst the first six months of the year, from January to June, have the least. One heap of sweet potatoes is SBD 10.[28] Chinese cabbage prices are consistent throughout the year. Some villagers state they are generally happy with the prices they receive for their products, whilst others state they are not satisfied with the prices and do not earn enough to meet their basic needs. Since the prices are fixed per heap of cabbage sold, there is no way to negotiate a better profit margin.

In addition to the Munda market, two outlets are located within the village of Baniata. On Fridays, villagers sell their products within the Baniata community. This market is important for garden produce, although it now features more baked and fried foods such as ring cakes.

Income earned from market sales is used to purchase food not available in Baniata, as well as non-food items from the Munda shops and markets. A rough estimate of money that an individual can spend in a single day in Munda after marketing is around SBD 300.[29] If families have money left over from their purchases, they give a small fee to help support the village. Villagers feel the prices for foods in Munda are reasonable and affordable – particularly at the stores. Certain foods such as taro, yam, ***pana***, fish and corned beef tend to be more expensive. Foods at the Munda markets are usually fresh, as produce is typically picked within the past day, and fish is sourced directly from the ocean. Noro market is the only exception, where the fish is stored in freezers, often for too long, and then sold to local Solomon Islanders.

Adequacy of diets

Local foods are sourced from home gardens, markets and wild collected foods. Villagers estimated that around 60 percent of foods come from food gardens and locally kept animals, 10-20 percent come from the wild, either hunted, fished or collected, and 20-30 percent come from the market and stores in Munda.

At some point throughout the year, many households in the community experience food insecurity. Issues include worrying they might not have enough to eat, not having access to healthy foods, eating only a few varieties of foods, and not having enough for the needs of the entire household. If they are completely out of foods, villagers may ask if they can harvest foods from a relative's garden. Rice is a commonly consumed food during times of low food access, as it is readily available and affordable.

According to the women in focus group discussions, household food insecurity is most experienced from April to July, the gap after the main harvest. Men state that between January and March it is difficult to provide enough food, mainly because sweet potato varieties that are planted in December and January do not provide the same yield as before. For example, the sweet potato plants may look healthy, but tend to have lower yield for the tubers. Men say this is most likely due to the increased duration of the rainy season. Additionally, the seas tend to be rougher during the rainy season, which reduces the catch, as the men venture to sea less frequently. What is caught, together with other agri-food products, is difficult to get to the market during this period, again because of the rough seas.

During the periods of food insecurity, villagers increase their consumption of cooking bananas and less-preferred varieties of roots and tubers such as wild yams and taros to supplement the low supply of sweet potatoes. The main taro species and varieties eaten at this time are ***voruku*** (*Alocasia macrorrhizos*, giant taro), ***ozo*** (*Alocasia macrorrhizos*, giant taro), ***kakake*** (*Cyrtosperma merkusii*, swamp taro) and ***karuvera*** (*Xanthosoma sagittifolium*, Chinese taro). Together with changing taste preferences, in the past taro was the staple food, which is slowly being replaced by sweet potatoes.

Traditional foods are eaten daily in Baniata, but are often mixed with imported and highly processed foods such as instant noodles, white

[28] Equivalent to USD 1.24.

[29] Equivalent to USD 37.3.

rice, biscuits, table sugar and vegetable oils. In addition, consumption of regionally caught canned tuna, called taiyo, from the nearby Noro tuna factory has increased.

In contrast with the common assessment that food diversity is high in the local food system and remains stable, diet quality is likely not sufficient. Community members all agree that rice dominates the plate and there is a heavy reliance on carbohydrate-based foods such as roots, tubers, rice, noodles and sugar-sweetened drinks. The major source of protein comes from canned tuna and other seafood. Protein intakes are low, as other high-quality sources such as meat, eggs, dairy and legumes are rarely consumed. Meat and dairy are rarely purchased from the market due to expense. They are commonly consumed once a month. Pulses are consumed twice a week between June and August when it is the season. Though prevalent throughout the village, seeds, orange fruits and red fruits are not consumed frequently. Coconut milk, oil or shaved coconut is incorporated into almost every meal, with processed commercialized vegetable oils starting to become more commonly used.

The perception of community consumption varies dramatically depending on the demographic. Older women estimate 75 percent of food is local, whilst only 25 percent is processed. Younger women think it is split evenly, and men think 25 percent of the food consumed is local whilst 75 percent is processed. However, villagers recognise that shifts away from traditional foods are resulting in unhealthy people and increased rates of non-communicable diseases. There is no clear local classification for foods or dietary guidelines in the village. Men classified local foods into four groups: meat, fruit, leaves and energy. Women classified local foods into three groups, which more closely aligns with the National Dietary Guidelines from Solomon Islands: energy foods, bodybuilding foods and protective foods. This comparison between men and women indicates that women are more knowledgeable of the national dietary guidelines than men.

TABLE 4.8. Men's and women's classifications of local foods

Men's classification of local foods				Women's classification of local foods[30]		
Meat	**Fruit**	**Leaves**	**Energy**	**Energy food**	**Bodybuilding food**	**Protective food**
fish pig opossum	pineapple ***pawpaw*** jackfruit	slippery cabbage fern pumpkin leaves shallot	potato breadfruit ***karuvera*** banana	taro potato yam banana ***pana*** cassava	fish crab	***pawpaw*** pumpkin cabbage coconut

Men perceived a healthy and well-nourished person as someone who is "a very happy person who likes to play all the time, always ready to work, does not get sick easily, not fat and well built. Some healthy people do have little bigger belly because they eat well." Women perceived a healthy person as someone who is "strong, fat, looks beautiful and handsome, clever and happy, looks very young and bright, willing to work and his/her body grows well."

There are numerous perceived and actual barriers to food security and diet quality. These include seasonal availability of home garden foods, local irregular production such as eggs, pests and diseases of crops, changes in weather patterns and impacts on seas, high costs of food, in particular meat and milk, growing interest in convenience foods, and shifting taste preference from traditional crops to processed foods. When asked, villagers wished they could purchase and consume certain foods more frequently – most of

[30] Energy food: carbohydrate-rich food; Bodybuilding: protein-rich food; Protective food: vitamin- and mineral-rich food.

which were processed foods, including cordial, mineral water, ice cream, butter, cola, onions, chicken wings, corned beef and bread. Villagers expressed interest in consuming more meat if it were more accessible.

Changes in the provision of livelihoods and social well-being over time

In the past, money was not required in Baniata. Villagers depended on their traditional crops for survival. There were no shops and villagers were satisfied with what they had. With globalization and the introduction of income, money is now required for foods, materials, transport, school fees, clinic fees, travel, and community contributions for special events or projects.

Prior to independence from British rule, Solomon Islanders made little money, but the British pound was worth enough to pay for an acceptable standard of living. After independence in 1978, Solomon Islands transitioned to the SBD, and everyday prices for all Solomon Islanders increased significantly. The majority of the people in the village now earn money from agri-food production activities, as traditional crops progressively became a source of income. With larger home gardens and the increasing ability to sell to markets, livable wages are now possible. Villagers now work harder than before independence, but recognise that income opportunities are rising as market sales and opportunities expand.

Incomes are rising due to overall increased sales of home garden products and handmade crafts and goods. Increased incomes are now altering relationships amongst villagers, as some villagers are hiding their fast-growing varieties of crops from their neighbours. Other villagers are even harvesting their neighbours' crops or "forgetting" to bring their neighbours' crops to the market for sale.

Meanwhile, villagers state that the quality of diets and food supply has changed dramatically over the past three to four decades. Since the 1990s, there has been an increase in imported and processed foods. If the market in Baniata was previously used to sell fresh produce, eggs and fresh fish, it now sells primarily nutrient-poor, highly processed baked goods such as ring cakes, donuts and sweet breads. Villagers are more often opting for this type of food over wild collected foods, as they are easier to find, cook and prepare. Traditional foods are also declining in consumption, as many are sold for cash to buy non-food products or to pay for children's school fees. In the past few years, crop yields have been decreasing, which reduces even further the amount of crops able to be sold at the market. Harvests have changed over time. The ***ngali*** nut harvesting was previously between September and February; now harvesting continues until June, which is assumed by community members to be caused by longer and more intense rainy seasons. Fish stocks and sizes are also declining, with negative impacts on dietary quality, especially protein intakes, and income generation. This, along with a tuna cannery opening in the nearby town of Noro in 1977, has shifted local diets away from fresh fish to canned tuna. The type of tuna consumed locally is "second grade tayio", made of the dark flesh that is less desirable and not suitable for export. In addition, new techniques of removing skins from traditional foods such as roots and tubers due to a preference in taste are making the food less healthy. This has resulted in poor health outcomes such as high blood pressure, diabetes, increasing rates of obesity and being overweight, to name a few.

2. RESOURCE USE EFFICIENCY

Land and soil

The landscape is characterised by sand along the shorelines followed by loamy soils inland. After this, the soil then becomes more stony/mixed gravel with clay, and towards the bottom of the hills and mountains it eventually becomes silt. Villagers prefer the soil that is less stony with more clay, a silty texture, and one that has been fallowed for a longer period. Soil quality is better immediately behind the shores or coconut plantations. These soils are deeper with less or no stones or gravels. This is unlike the soils closer to the foot of the mountain ranges, which are stony/gravelly due to the continuous accretion from the streams coming from the mountains.

Choices for crop cultivation are strongly connected to the landscape. Soft soils are usually planted with peanuts. Swampy areas along the riverside are used to cultivate crops such as ***kakake*** and ***ruta*** (*Colocasia esculenta*, taro). Home gardens are placed within close proximity to a river for easy water access. Sandy areas along the coasts are used for coconut plantations and dry loamy soils are used to produce crops like taro and sweet potatoes. Baniata's home gardens, ***ngali*** nut agroforestry systems, and coconut plantations are entirely organic, as villagers do not use synthetic pesticides, herbicides or fertilizers. Locals generally view their soil as very fertile compared to other islands in the Western Province. However, maintaining soil quality is a rising issue in Baniata.

Practices that aim to maintain and enhance soil fertility are often not adequate to cope with rising pressure on soil quality. Land fallowing and crop rotations are practised throughout the village, in the following sequences: sweet potato, cassava and ***karuvera***, followed by a three- to five-year fallow; potato, potato, potato and cassava, followed by a three- to five-year fallow; and watermelon, potato and cassava, followed by a three- to five-year fallow. Some villagers are beginning to integrate legumes such as bean or peanut in a crop rotation schedule to enhance nitrogen fixation. Most villagers do not improve soil fertility with compost or nitrogen fixation. Whilst some still use the old practice of stick for tilling and planting, most now use the hoe to cultivate.

Today, erosion is controlled by moving gardens to a different site and allowing the old gardens to fallow. Some growers use garden residues or rubbish such as rice sacks or containers as physical barriers to contain the soil and prevent erosion. Others dig small drains to divert water flow away from their food gardens. Villagers also avoid cultivating on slopes to minimise erosion.

Labour and fuel energy

Baniata is reliant on non-renewable and externally sourced energy for certain essential tasks. The primary use of petrol is to transport villagers and their goods to local markets in Munda or Noro, which are only accessibly by boat. The village owns a few petrol-powered generators; however, these are not commonplace and are being replaced with solar panels.

Most households have solar panels that were provided by a government grant. Kerosene lamps are still used, but not as frequently due to the increase in solar lighting and rechargeable torches. Candles made from ***ngali*** nut oil, coconut oil lamp and disposable operated torches are now rarely used. Firewood, collected from the surrounding landscape, is used for cooking and processing copra and ***ngali*** nuts. Women and children work together to collect firewood each week. Collecting firewood takes around one half day to complete. Wood is abundant and collected from old or fallen branches of ***ngali*** nut trees. Locally, demand for firewood and other fuels such as coconut shell and husk, as well as ***ngali*** nut shells, had increased due to increased processing of ***ngali*** nut and copra for export, combined with an increase in the village population.

In the village, men are responsible for clearing forests for new garden plots, gathering coconuts for copra, building new homes and teaching these skills to young boys. Besides their role in collecting firewood, women are also primarily responsible for agri-food activities including gardening, gathering wild foods such as ***ngali*** nuts, cooking, and selling goods at markets. Children help their parents with their gender-specific roles around the village. Boys typically help with planting cassava, hoeing mounds, planting sugar cane, clearing the gardens, and fishing. Girls assist with weeding, planting crops such as potato, corn, ***kumara***, etc., and collecting vines.

Human energy demands consist of gardening, collecting firewood that is primarily done by women, processing coconuts into copra, and processing ***ngali*** nuts. The food system is based on a subsistence farming system so labour requirements are high. The whole family is involved in food production and this is usually enough to meet the daily food needs, as well as yield surpluses that can be sold without needing extra labour.

Waste

The most common sources of waste include bio-organic waste from the kitchen, home gardens and crop processing (such as ***ngali*** nut skins and shells), plastic bags and wrappers, human sewage, medical waste from the health clinic, and leaves from trees in the village. The most concerning wastes are plastics and human sewage. Although people sometimes reuse plastics, they are usually burned or buried. However, a large percent of plastics end up in the sea, along the shores, or littered around the village. Medical wastes are typically buried in the ground.

Waste minimisation is not practised according to the community. However, some waste is reused. Kitchen scraps are recycled into animal feed or placed on banana trees for compost. Plastic instant noodle wrappers and rice bags are used as seedling starters, by placing soil and seeds into the plastic wrappers, and placing them in the sun. Plastic shopping bags are often reused for selling dried ***ngali*** nuts and for covering hanging fruits as a pest control method. Plastic bottles are reused for water collection. Other uses of plastics include weaving into door curtains, artificial flowers and purses.

Changes in resource use efficiency over time

Traditionally longer fallowing times or permanently moving to a new garden site was commonly practised. Increasing populations and decreased land availability has reduced the amount of time villagers have allowed land to fallow. Mixed cropping was previously practised in the distant past, usually consisting of small parallel plots with a different species or variety in each plot. This has been said to decrease the soil quality and therefore has reduced the efficiency of both land and soil use. In the past, fallowing and digging with stick minimised soil disturbances and helped control soil erosion. Pests and diseases are on the rise, including rat infestations, causing villagers to prioritize crops that rats consume less frequently.

Human labour demands have increased to account for a rise in agri-food sales and feeding a growing family size. The demand for cash through the sale of crops requires a larger plot of home gardens and this demands more labour. In the past, men would chop down forests by hand but now the slash and burn technique is the dominant method of clearing forests. Increased labour needs have women hiring others to help with the growing and cultivation of agri-food products. An example of this is ***ngali*** nut processing. A family would provide tea and sugar or cook rice, tuna and noodles to attract villagers to their nut-cracking sessions.

The community uses few modern or mechanized farming tools, except for diesel boat engines. In addition, the level of drudgery decreased after hoeing was introduced. Machetes, large knives and axes make it easy to clear the forest for cultivation compared to in the past, where they used stone axes that required a lot of human effort. The community decided to decrease external inputs in general, not just within agriculture, which was facilitated in 2011 when a local parliamentarian donated solar panels to reduce reliance on kerosene lamps and diesel generators for electricity and light.

In the past, women would walk for 10-15 minutes to collect water twice daily from the closest stream. In 1986, a pipe system from a nearby waterfall was established and taps were placed in various locations around the village. This greatly reduced the time required to fetch water, which now only takes around two to three minutes.

However, water quality varies, particularly during the rainy season when it is said to taste different and can become dirty. Some villagers blame this on leaking pipes that run to the village and the establishment of food gardens close to the water source. Because of this, sometimes women will walk to the water source to fetch fresh drinking

Coconut plantations lining the black sandy shores of Baniata Village.

water. People now live alongside the river, which is creating new issues around water pollution and safety. The neighbouring village of Havila previously had water run through the village, but now they must walk to the river to fetch it due to the small streams drying up. Men state that recent landslides also changed the river patterns and slowed the flow of the water.

Waste management efficiency has decreased over time, as larger amounts of waste are now produced compared to the past. New ways of cooking are leading to increased kitchen waste, including peeling potatoes or taro skins, grating and scraping out the flesh of coconut before squeezing out the milk, or animal forage wastes. These wastes are disposed of by tossing them into the sea, or burning. Previously there was little external waste entering the food system. Now, due to imported and packaged goods, there is significantly more plastic waste. No apparent attempts have been made to address this issue, most likely due to lack of awareness about the dangers of plastics for marine animals, and the convenience associated with the use of plastic.

3. CONSERVATION, PROTECTION AND ENHANCEMENT OF NATURAL RESOURCES

Crop and livestock biodiversity

Baniata has over 53 crop species and 2 livestock species. The most prominent crops in Baniata are tubers and banana, which have numerous varieties: banana (19 cultivars), yam (17 varieties), cassava (8 varieties), taro (6 varieties) and sweet potato (11 varieties). Banana, yam and taro were traditionally the local staple crops, whilst cassava and sweet potato have been introduced more recently. Several varieties of banana and root crops are yellow or light orange fleshed.

Despite the diversity of crops maintained, villagers agree that agrobiodiversity is decreasing due to the increasing reliance on imported foods. Additionally, the opening of markets has led to impacts on the local environment through the introduction of a variety of crops and pests. This is particularly the case of the improved crossbreed of pig, nowadays raised by many households in large areas. Other introduced plant and animal species are still grown and raised by few households on small areas, such as wild pigs, featherless neck chicken, hybrid variety of guava, varieties of mangos, and hybrid variety ***pawpaw***. However, community members usually prefer the local varieties. Although not cultivated extensively, four varieties of gourd have been introduced in the food system.

Certain seeds are commonly traded within the community, particularly if they do not have high market value. Seed access remains a limitation for growing more vegetables in Baniata. Corn seeds are usually dried above the fireplace to preserve until next planting. Watermelon seeds are often shared with families free of charge and can be stored for up to two years without losing viability. Vegetable seeds can be accessed from the agricultural office in Munda, however, supply is irregular and seeds are not free. Crops with a higher market value are not shared because of increased competition in the marketplace. The local practices of ensuring household access to quality seed and an exchange of varieties are described below:

TABLE 4.9. Seed sharing and saving

Seeds shared in Baniata	Seeds shared with other communities	Seeds accessed from market, government, NGOs	Seeds saved from farm
watermelon, eggplant, maize, bean, cucumber, pumpkin, mandarin, pomelo, snake bean (gourd)	watermelon, eggplant, maize, bean, pumpkin, mandarin, pomelo, cucumber, local tomatoes	Chinese cabbage, saladeer, hybrid varieties of cucumber, tomatoes, capsicum	watermelon, maize, open pollinated bean, pumpkin, local tomatoes, cucumber

TABLE 4.10. Seed systems of traditional crops

Varieties shared within community	Varieties shared with other communities	Varieties of breed sources
bananas (fizi vahu, zario vahu, makira vahu) -sweet potatoes (tau mahu, vaero) -***ozo*** -taro	bananas (fizi vahu, zario vahu, makira vahu) -sweet potatoes (tau mahu, vaero) -***ozo*** -taro	-banana -sweet potatoes -taro -fruit trees -coconuts

Wild harvested plants and animals

There are minimal restrictions on harvesting wild plants or animals. Fishing is restricted after the death of a villager, and wild foods cannot be collected in sacred or taboo areas. At least 50 species are fished for food, including 37 fish species, 6 molluscs, 4 crustaceans and 2 turtle species. In addition, 3 mammal species and 8 bird species are hunted. The eggs from 5 bird species and 2 turtle species are gathered. In addition, leaves from 7 wild plants and 1 species of seaweed are harvested as vegetables, along with 6 wild fruit species. Wild foods collection is declining due to preference for imported foods and population increases.

Ecosystem conservation and protection

There are traditional areas where ecosystems are protected under informal schemes. These areas are known as taboo areas, where villagers cannot enter. It was believed that these areas were used by their ancestors and are now recognised as sacred areas. A Baniata village elder oversees certain protected areas, such as Lake Suri. The wild animals such as flying fox, fish, crocodile and lizards near this lake cannot be hunted. Men feel the landscape and seascape ecosystem protection is adequate and stable; women think protection is not adequate.

Similar to the past, the community relies mostly on natural pollination. Locally important pollinators include bees, butterflies, ***viku*** (yellow birds), flying foxes and ***ghausu*** (doves). Villagers do not actively engage in pollination due to limited knowledge. The community perceives current levels of pollination are sufficient, as indicated by yields of fruits and nuts around the village. However, many note that butterflies are no longer common, probably due to introduced plants that are considered toxic to the butterflies.

Changes in the conservation and protection of resources over time

The reliance on local, traditional animal breeds and plant species and varieties has decreased over time in Baniata. For instance, the Bougainville banana was introduced in 1992 and provided Baniata with a new and novel variety that was easy to grow. However, this was at the cost of the rich plantain and banana biodiversity that existed in the landscape, including the Vitamin-A-rich Fei banana, which used to be a staple that was roasted each morning over an open fire, providing a nutritious breakfast for the whole family.

Nowadays, traditional varieties are replaced by new varieties entering the marketplace. Less land space is expected to be available in the future, as these areas have reached the foot of the mountains. It is anticipated that sustainable intensification practices such as crop rotations and shifting between fallowed plots will need to be practised to ensure sufficient food is produced for the increasing population and, hence, demand.

Fish stocks are declining, as villagers state they must travel much further to catch fish. Villagers remember a time when rivers were full of fish and eels, but due to flooding and increased populations, river stocks are much lower. Timber trees, especially ***vasa*** and ***gema*** used as firewood, are also declining and becoming increasingly difficult to access due to overutilization and lack of domestication. Villagers are adapting by alternating species for timber to build their homes.

Men feel villagers are managing natural resources sustainably and that they are preserving the land for the future. For example, harvesting of fish in the sea and harvesting of animals in the bush is done in a sustainable manner, as they believe they hunt, catch or harvest only the quantity that is needed to feed their families. Home gardening plots can be moved when needed, which allows the opportunity for land to fallow and the soil to regenerate. On the other hand, women state that sustainability now is declining. In the past, small fish were returned to the sea, yet today fish of all sizes are kept for consumption, resulting in overharvesting. Women also noted that some villagers poison the river to catch fish, causing all fish in the river to die.

4. RESPONSIBLE AND EFFECTIVE GOVERNANCE MECHANISMS

Governance of natural resources

Village elders govern the use of natural resources. If someone wants to use natural resources, they must first consult the elders. Elders traditionally help resolve land disputes between families. Solomon Islands' government does not own land in Baniata. Everyone in the community has customary or formally recognised rights over land but the elders are the people who know most about land rights. The individual members of the community can farm and work on any unoccupied land, as long as they have consulted and received approval from the village elders. The Irugo elders have the majority when community decisions need to be made but will typically gather input from each household. As the elders age, they pass knowledge to their successors.

Fire roasted and beta-carotene rich Fe'i banana (*Musa x troglodytarum* L., Musaceae).

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Baniata has a matrilineal system of land use rights and management. Women are the primary managers of the land. If a woman has a son, the son will inherit the land-use rights from his mother. However, both males and females have equal rights to use the land. Land has been handed down from elders to a tribe of family members, including their sons and daughters. Certain actors outside of the community can also use land with permission from the elders, including missionary groups, teachers, church leaders, nurses and pastors. Certain villagers hold land use rights in other communities too.

Changes in governance of natural resources over time

Community-based landscape planning is fluctuating and beginning to decline according to the villagers. In the past, natural resources were well cared for by the chiefs and leaders in the community. When the last chiefs died, no chiefs took their place and now elders have taken charge. However, elders are not governing the natural resources as effectively as chiefs once did. There are also no formal institutions to help govern the use of natural resources.

Baniata is home to one of the few nesting grounds of the massive yet endangered leatherback turtles. Previously, villagers would eat the turtle eggs as a source of nutrition, as each turtle lays anywhere from 300 to 700 golf-ball-sized eggs during her 10-day nesting period. However, now the Tetepare Descendants Association is helping to protect leatherback turtle populations by offering incentives to protect turtle egg nests from being harvested by villagers. However, many villagers – particularly youth – still collect these eggs at night and consume the eggs as food.

5. RESILIENCE OF PEOPLE, COMMUNITIES AND ECOSYSTEMS

A summarized assessment of 13 indicators of resilience is presented below.

1. Exposed to disturbance: Over the past few decades, villagers have experienced numerous disturbances. However, villagers cite more frequent natural disasters. Increasing intensity of weather patterns are inhibiting stability – from increased frequency of cyclones and flooding, to landslides drying up rivers. Tsunamis have also occurred after the earthquakes in 2007 and 2010. Further, pests are on the rise, jeopardizing the productivity of the local agri-food system.

2. Globally autonomous and locally interdependent: The community is self-sufficient, with 70 percent of the food production coming from farming, fishing and wild sourcing. However, an increasing percentage of their food is sourced from imported or processed foods (30 percent). Trade between villages is increasing with the improvement of market access via petrol-powered boats. Only a few programmes or local initiatives exist to promote agri-food products in the community, such as for ***ngali*** nuts.

3. Appropriately connected: The village is appropriately connected to two major markets – Munda and Noro. The barriers to reaching these markets include lack of access to boat use and ownership, rough seas, costs of petrol, and seasonality of produce.

4. Socially self-organised: In the community village elders make community decisions based on input from the villagers. Previously, Baniata had village chiefs, of higher status than village elders, and concerns have arisen with their recent passing. There is a strong notion of support within the community, as villagers regularly give a portion of their agri-food earnings to help support village expenses.

5. Reflective and shared learning: The village maintains traditional knowledge that has been passed down verbally for generations, such as songs written about local recipes (***masi masi***). New farming technologies have reduced the drudgery involved with agricultural production, and motorboats and improved fishing gear have extended the ability of villagers to catch more seafood. However, both men and women feel agricultural innovation is decreasing and that their methods need improvement.

6. Honours legacy: Elders are respected in the community as the primary decision makers. The community maintains many of its traditional ways of life, as the villagers have limited access to electricity or cellular phone service. Traditional knowledge and the local languages are not written or documented, and thus are slowly disappearing. There are some initiatives by the youth to reinvigorate pride and passion around the local food culture, which can be linked with the transfer of traditional knowledge from elders to the younger generations.

7. Builds human capital: Knowledge transmission mainly happens through storytelling, songs and teaching by watching and doing whilst carrying out daily agri-food activities. The teaching is often gender-specific per agri-food activity. The transferring of knowledge is seemingly decreasing due to the community's increased reliance on imported foods. Further, elders are concerned about a perceived lack of interest by the youth in learning traditional recipes and ways of life. However, when asked, the youth showed much interest in continuing agricultural and cultural traditions.

8. Coupled with local natural capital: The community's food system is intricately linked with the natural resources found in the local land- and seascape. Negligible external inputs are used for agri-food production, as Baniata's food system is 100 percent organic. Villagers hold high respect for the natural environment as it provides them with the majority of their food, shelter and fuel. Increased levels of waste seem to be a concern, due to increasing demographic pressure and reliance on packaged foods.

9. Ecologically self-regulated: The villagers have a strong connection with nature and view it as a necessary and positive relationship to ensure their own good health. Soil health, water quality and quantity, and energy sourcing are all viewed positively with minor areas of improvement required.

10. Functional diversity: Multiple food groups are represented in Baniata's agricultural production and land- and seascape, including starches, pulses, fruits, nuts and seeds, leafy vegetables, other vegetables, meat, poultry and fish, and eggs. However, diversity in crop production is decreasing due to the increasing reliance on imported foods.

11. Optimally redundant: All villagers rely on agri-food products as a primary source of income. Multiple varieties exist of many types of crops, including potatoes, bananas, ***pawpaws*** and green leafy vegetables. Of 53 crop species maintained, at least 25 have multiple varieties so that the food system generates 156 crop foods in total. Whilst the diversity of crops is declining, it is believed that in particular the local traditional varieties offer resilience against climate and pest disturbances and help promote nutrition adequacy.

12. Spatial and temporal heterogeneity: The landscape is located on a small, forest-filled peninsula surrounded by the open ocean. A large mountain limits the expansion of the village. The villagers use the available land to grow agri-food products through traditional farming methods, agroforestry and collection of wild foods.

13. Reasonably profitable: The villagers are generally satisfied with the income earned from selling agri-food products at the markets, such as home gardens' produce, copra and ***ngali*** nuts. The income is mostly used to pay for expenses such as school fees for children, houseware items and imported foods. Incomes earned by villagers are increasing due to the price villagers can get for their products at the market. However, the reliance on boats to reach the markets creates barriers for some community members in selling their produce, especially for women.

SECTION 3 CONCLUSIONS AND FUTURE PROJECTIONS

1. FOOD SYSTEM SUMMARY

The agri-food production system in Baniata is diverse and consists of small-scale agriculture, agroforestry, wild food collection of flora and fauna, and fishing. Food is mainly grown in home gardens and collected wild (70 percent), and increasingly by purchasing imported and processed foods (30 percent). The variety of crops grown in Baniata has shifted due to changing preferences of the villagers, reliance on imported foods and climate change. Regeneration of home gardens through fallowing was practised more in the past, but due to land constraints and a growing population, fallowing is decreasing. All villagers sell agri-food products such as copra, and prepared food items such as ***masi masi*** for income, and most of them rely on these sales as their primary means of income generation. Income is spent on foods from the market, household goods, and school fees for children. The primary market is Munda, which is a 90-minute petrol-powered boat ride away. There are only two main boats, which can hold around 8 to 12 people. These boats are the primary means to access markets to sell agri-food, so villagers rotate turns so that all households get a chance to earn an income. Additionally, a market within the village primarily sells baked goods. Overall, the food system is becoming less reliant on traditional foods, and increasingly reliant on imported and processed foods.

2. HIGHLIGHTS OF SUSTAINABILITY ASSESSMENT

Baniata and surrounding villages rely on the land for the majority of their sustenance. The village grows food organically and crops are primarily rain-fed. The agrobiodiversity of food production and availability is quite high, with over 127 food-providing species and their respective varieties and breeds for cultivation or collection from the wild. There is a wide diversity of root vegetables, bananas and leafy greens. Some varieties are local whilst others have been introduced to the community. Villagers use food scraps mostly to feed animals such as free-roaming chickens or pigs. The composting of food is not widely practised, and if foods were composted into a nutrient-rich soil amendment, this could enhance soil quality and fertility. Food is prepared and cooked using locally sourced firewood. Fishing was previously more sustainable, but now there are fewer restrictions on the size of catch – which is believed to reduce the amount of fish available for consumption.

Villagers feel the diversity of crops is decreasing due to reliance on imported and processed foods. Changes in market preferences, climate change and increasing pests are also dictating which crops are grown more frequently. Human waste management is not entirely sustainable, as villagers now use the beach as the primary waste area. This will likely be an increasing issue as the population continues to rise. Plastics litter the grounds and beaches due to mismanagement. Previously plastics were not widely used, but now since processed foods are increasing, plastic wrappers and waste are as well. Villagers feel the environmental conditions are decreasing because of plastic waste. Protection of land use remains stable, as land ownership on the individual level is not allowed. However, due to the increasing population, land for agri-food purposes is decreasing. Land is not able to fallow for long periods as it was in previous generations.

Overall, resilience has decreased over time, correlated with diminished reliance on homegrown and wild collected foods for the diet, and loss of knowledge of traditional recipes and ways of life in the Baniata community.

3. FUTURE PERSPECTIVES

Both men and women agree that they want to maintain traditional foods and recipes and pass them down to future generations. However, villagers are concerned that if no intervention is made, they will see a continued reliance on highly processed unhealthy foods, and a decreased reliance on their local food system. Villagers state that rice will likely continue to replace traditional staple crops in local diets. These changes are decreasing the food sovereignty and food security by means of reducing access, utilization and stability of the food supply, affecting their quality of life and contributing to the rise of non-communicable diseases such as heart disease and diabetes.

Decreasing land fallowing and climate change lead to decreasing yields of crops. To improve yields, it will be imperative to employ improved crop rotation and composting techniques to return nutrients to the soil. Additionally, food preservation is not widely practised, which can put the villagers at risk when natural disasters strike. In the future, villagers predict local agrobiodiversity will continue to decrease if no intervention is made. The school curriculum does not include education on local foods. Men are slightly more optimistic than women regarding the preservation of local varieties of foods. Meanwhile, there is a strong consensus that the transmission of traditional knowledge is declining, such as wild collected foods, hunting and fishing techniques, and utilization of local plant species and varieties. In addition, the majority of villagers also feel that the documentation of traditional knowledge is severely lacking

When speaking to the villagers about traditional foods, there was strong pride in traditional varieties of crops and recipes. Children are aware of local foods and 75 percent of the children enjoy them, whilst 25 percent prefer processed foods. Twelve of the 13 children who participated in the discussions stated they want to take over their family farm in the future, they want to grow their own food, make money from copra, and ensure that their own children will have enough food to eat. Interestingly, children who had these aspirations did not attend school. Those who expressed interest in leaving had aspirations to achieve higher education and eventually return to the village with their families. Children also shared interest in local foods, although the older adults assumed they are disinterested. Leveraging this passion could be key to keeping these foods and traditions alive and vibrant within indigenous Solomon Islands' communities.

4. CONCLUSIONS

Villagers are proud of their community and agri-food production. However their food system is rapidly changing due to internal and external pressures, resulting in rising levels of food insecurity and malnutrition. Baniata used to be fully self-sufficient, using the local sea- and landscape around the village. However, over the past 50 years, the community has become slowly integrated into wider markets, which is having positive and negative effects. Linking up with food systems beyond the immediate local food system of Baniata has increased access to new foods. Processed foods can be preserved and used during seasons of food insecurity. However, processed foods are also shifting diets toward lower quality, nutrient-poor foods, which leads to poorer health outcomes and decreases local agrobiodiversity.

Climate change is another big risk to their resilience and the community may not be prepared enough for it. Villagers need improved access to and sharing of climate-resilient seeds, planting materials and other adaptation strategies. Improved food preservation can also help prevent food insecurity during times of low food availability. Ensuring a sustainable food system for Baniata is essential for preventing the continued rise of malnutrition and local food system degradation.

Chapter 4: Dietary agrobiodiversity for improved nutrition and health outcomes within a transitioning Indigenous Solomon Island food system [Published PDF]

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ORIGINAL PAPER

Dietary agrobiodiversity for improved nutrition and health outcomes within a transitioning indigenous Solomon Island food system

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Abstract
Indigenous food systems of Pacific Small Island Developing Countries contain vast biological and cultural diversity. However, a nutrition transition is underway, characterized by shifts away from traditional diets in favour of imported and modern foods, contributing to some of the highest rates of obesity and Diabetes Type 2 Mellitus in the world. Using a mixed method approach, this study aimed to assess dietary agrobiodiversity's relationship with nutrition indicators related to diet quality and anthropometrics within the context of the rural and Indigenous food system of Baniata village, located in the Western Province of Solomon Islands (Melanesia). A secondary aim was to evaluate the contribution of agrobiodiversity from the local food system to diet quality. A comprehensive nutrition survey was administered to the women primarily responsible for cooking of randomly selected households ($n = 30$). Additionally, 14 participatory focus group discussions captured the historical narrative of food system transitions, were hosted over a period of seven days, and included men, women and youth. Dietary intakes of the participants were reported below the estimated average requirement (EAR) for several essential nutrients, including protein (53%), calcium (96.6%), vitamin B1 (86.6%), vitamin B2 (80%), vitamin A (80%), zinc (40%) and fibre (77%). Focus group participants built a timeline of key historical and climatic transitions perceived to be drivers of dietary shifts away from traditional foods and towards imported and processed foods. Participants identified 221 species and varieties of agrobiodiverse foods available for cultivation or wild collection. Based on 24 h diet recalls, 87 were found to be utilised. Participants who consumed foods of a wider diversity of species richness had a higher probability of achieving recommended nutrition intakes and a lower body fat percentage ($r^2 = 0.205$; $p = 0.012$). Our results suggest a nutrition transition is underway, and strategies harnessing traditional knowledge of nutrient-dense, agrobiodiverse foods can help improve food and nutrition security.

Keywords Sustainable diets · Food security · Wild foods · Pacific Islands · Melanesia · Diet quality

1 Introduction

Pacific Small Island Developing States (PSIDS) are experiencing disproportionate threats to their food and nutrition security through rising rates of malnutrition and increased vulnerability to climate change (Allen, 2015; Haddad et al., 2015; Hughes & Lawrence, 2005). The sustainability of Indigenous food systems are particularly at risk from both increased consumption of nutrient-poor, imported foods (McIver et al., 2016; Shrimpton et al., 2016) and rapidly changing weather patterns (Allen, 2015; Warrick et al., 2017). Climate-related events, such as stronger and more frequent storms, heavier rains, longer droughts, and rising ocean temperatures all add pressures to the already stressed food systems. Climate change is projected to magnify all forms of malnutrition (Phalkey et al., 2015). The future of habitation

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and agricultural production in PSIDS relies on adaptation to the adverse impacts of climate change and malnutrition. To date, insufficient research exists examining the role between food production systems, agrobiodiversity and malnutrition in PSIDS (Haynes et al., 2018).

Sustainable Development Goal (SDG 2 (Zero Hunger) is focused on eliminating all forms of malnutrition through sustainable diets. Sustainable diets are increasingly seen as a precondition for assuring food security (Berry et al., 2015; Canavan et al., 2017; Smith & Gregory, 2013). Sustainable diets are defined as being 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 (Burlingame & Dernini, 2012). Achieving SDG 2 requires multifaceted coordination between agricultural, nutrition and health sectors, all encouraging sustainable food systems for current and future generations, particularly within the scope of climate change.

Transitioning foods systems characterized by a shift away from local and traditional foods towards globalised food systems is eliciting a rise in food and nutrition insecurity and non-communicable diseases (NCDs) across many PSIDS (Foley et al., 2011). Increasing reliance on imported and ultra-processed foods, which are typically nutrient-poor and calorie-dense, is a leading driver of malnutrition and contribute to NCDs (Hughes & Lawrence, 2005; Thow et al., 2011). Furthermore, as global anthropogenic CO_2 emissions continue to rise (with negligible contribution from those living in PSIDS), staple crops are projected to decrease in micronutrient density, adding increased nutritional vulnerability to women and children (Smith & Myers, 2018). Reliance on a smaller diversity of foods (diet homogenization) is creating conditions for poor diet quality and micronutrient inadequacies, as well as an increased susceptibility towards climate change (Sandifer et al., 2015).

Agricultural biodiversity, or agrobiodiversity, is a key component to ensuring healthy and sustainable food systems (Zimmerer et al., 2019). Agrobiodiversity includes all components of biological diversity related to food, agriculture, food culture, and related ecosystem services and is being lost at an alarming rate. Since the 1900s, nearly 75% of plant genetic diversity has been lost as farmers worldwide have left their multiple local varieties and landraces for genetically uniform, high-yielding varieties (Rischkowsky & Pilling, 2007). Today, only 12 species of plants and 5 species of animals make up 75% of the world's food supply (Convention on Biological Diversity, FAO, The World Bank, UNEP,, and UNDP, 2015). Transitioning diets and eroding cultural traditions in PSIDS threaten local agrobiodiversity and subsequently, the resiliency of local Indigenous food systems.

Neglected and underutilised species (NUS), one key component of agrobiodiversity, are gaining global attention as a potential solution towards sustainable food systems and have implications for providing locally available, culturally acceptable, nutritious, and cost-effective foods for vulnerable populations (Baldermann et al., 2016; Ebert, 2014; Raneri et al., 2019). NUS foods are often nutrient-dense, productive, ecologically-adapted and socio-economically accepted (Li & Siddique, 2018). For instance, researchers have identified some nutrient-rich NUS in PSIDS, such as the Fe'i banana (*Musa × troglodytarum L.*), a bright orange, carotenoid-rich species with 100 times the β-carotene content of the common Cavendish banana (2230 μg/100 g vs. 21 μg/100 g) (Buah et al., 2016). Improved understanding of agrobiodiversity in PSIDS can help guide sustainable agricultural diversification and intensification strategies aimed at achieving SDG 2.

1.1 Solomon Island food systems

Solomon Islands is an archipelago country made up of over 900 islands with a rich cultural and agricultural history. Indigenous Solomon Islanders (pop. $n = 612{,}000$) have traditionally relied on locally grown, biodiverse foods as their primary sources for food and nutrition. However, together with the wider Pacific region, they are now experiencing food system and nutrition transitions, and subsequent adverse impacts of changing diets (Santos et al., 2019; Sievert et al., 2019). Top imported items in 2016 include white rice (>43.2 k tonnes), wheat (>16.8 k tonnes), sugar (>6.5 k tonnes), and processed foods (>4.5 k tonnes) (FAO, 2019). By comparison, Solomon Islands produced 2.7 k tonnes of cereals domestically in 2016 (FAO, 2019). These changes are contributing to the rising rates of obesity and non-communicable diseases (NCDs) such as heart disease and diabetes, which are now the country's leading causes of mortality (Ministry of Health and Medical Services, 2017).

Using country-level data sourced from the FAO's food balance sheets, Solomon Islands food supply was determined to have deficits in vitamin B2, vitamin A, calcium, iron, and zinc (Gibson & Cavalli-Sforza, 2012). However, little recent dietary assessment data exist to confirm this. Most recent qualitative diet recalls show that diet diversity less than desirable, with consumption of nutritious food groups of fruits, vegetables and animal sourced foods low (Horsey et al., 2019). Government statistics indicate most Solomon Islanders currently consume fewer than five servings of fruit and vegetables per day (93.1%), and most adults are either overweight or obese (52.2%) (Solomon Islands National Statistics Office, 2015), contributing to the NCD epidemic of the Pacific Islands (*The Lancet.*, 2019). Drivers of overweight and obesity are multifaceted and complex and include cultural, economic, political and individual factors (Friel et al., 2007). In the Pacific, this trend has been linked to lack of physical activity, potential genetic predisposition (especially for Indigenous populations), globalization, and the associated dietary changes that results from increased availability and consumption of sugar and processed imported foods (Lin et al., 2018). Largely, recommendations in the Pacific centre on reducing the consumption of foods high in sugar, salt and fat. Yet, Solomon Islands is extremely rich in local agrobiodiversity and is recognised as a "Centre of Plant Diversity". It is home to over 4500 different species of plants - 3200 of which are Indigenous and at least 120 are edible and nutrient-rich (Convention on Biological Diversity, FAO, The World Bank, UNEP,, and UNDP, 2015). No studies in the Pacific have studied the relationship between consumption patterns of local agrobiodiversity, diet quality and healthy body weight or composition outcomes.

The prevalence of undernourishment in Solomon Islands was steadily improving from 15% in 2001 to 10.6% in 2011; however, as of 2017, the percentage of undernourishment has risen to 12.3% (FAO-Stat, 2018). The percentage of children under five who are stunted has declined from 32.8% in 2007 to 31.6% in 2015, however wasting has increased during the same time period from 4.3% to 7.9%, and childhood obesity increased from 2.5% to 3.9% (FAO-Stat, 2018). Anaemia among women of reproductive age was decreasing for a decade, but is now on the rise again, with 38.9% of women suffering from anaemia in 2016 (FAO-Stat, 2018).

Current literature investigating food system sustainability and nutrient intakes of Indigenous Solomon Islanders is limited. The population of Solomon Islands is projected to double in the next three decades, adding urgency to ensuring Indigenous food systems are resilient and able to provide sustainable diets, and food and nutrition security (UNDESA, 2012). Temperatures have increased between 0.12 and 0.18 °C each decade since the 1950's (Solomon Islands MET, 2011). Temperature increases are a direct threat to agricultural livelihoods, including main export crops of copra and palm oil. Rising sea levels pose major threats to Indigenous Solomon Islanders, particularly coastal villages. Warming seas are changing the migratory patterns of fish, and negatively affecting both local consumption and the regional fishing industries (Pacific Adaptation Strategy Assistance Program, 2012). Pests, king tides, and flooding are additional climate-related threats that are threatening local food systems (Warrick et al., 2017). More studies are needed to examine how agrobiodiversity and dietary diversity link to improved nutrition, and can help prevent malnutrition in all its forms while promoting sustainable food systems for the future.

Within the context of a transitioning rural and Indigenous food system, this mixed-method study primarily aimed to assess the relationship between dietary agrobiodiversity and health and nutrition indicators related to diet quality and anthropometric measures. Secondary aims of this study were to evaluate the contribution of agrobiodiversity from the local food system to diet quality. The women primarily responsible for cooking of selected households were measured for height, weight and body fat and administered quantitative nutrition surveys to assess nutrient intakes over non-consecutive days, annual household food security levels, and knowledge, attitudes, and practices (KAP) around food and nutrition. The study's third objective was to capture the historical narrative around the Indigenous food system, as well as current and projected future challenges towards the promotion of sustainable food systems using participatory focus group discussions (FGDs). We aimed to use the results of these combined methodologies to identify culturally appropriate and nutrition-driven solutions towards linking agrobiodiversity, nutrition and health for more food secure and sustainable diets.

2 Research context and methods

2.1 Research site

This study took place in Baniata, a rural coastal village surrounded by forested mountains located on Rendova Island, Western Province. Baniata is home to over 645 villagers and ~ 80 households (Fig. 1). The soils consist of black basalt, are well drained and slightly acidic. The area receives more rain on average than anywhere else in Solomon Islands (4000 mm per annum), and historically has distinctive rainy and dry seasons.

Baniata is located 90 min by motorized boat from the nearest town of Munda, where most market exchanges occur. Villagers live largely off the land, with limited outside contact (i.e. limited cell phone and internet coverage). Touo is the local language spoken, but the research was conducted in Pidgin (common language), as Solomon Islands are home to over 75 distinct languages. While data collected only applies to one village, the vast majority of Solomon Islanders reside in rural villages with access to the sea and bush, similarly to Baniata.

2.2 Study design

An observational cross-sectional study design was implemented using a mixed-method approach. Quantitative surveys examined detailed dietary intake, KAP, and anthropometric measurements of woman primarily responsible for household food preparation and gardening. These quantitative data complimented seven days of participatory FGDs with a diverse representation of men and women villagers, aimed at building a narrative around perceived food system changes, as well as documenting locally available agrobiodiversity.

Data were collected from July to August 2018, which is the lean season for villagers of Baniata. Local nutritionists from Solomon Islands National University attended a multi-day training to learn the quantitative and qualitative research methodologies. Nutritionists collected data under the guidance of

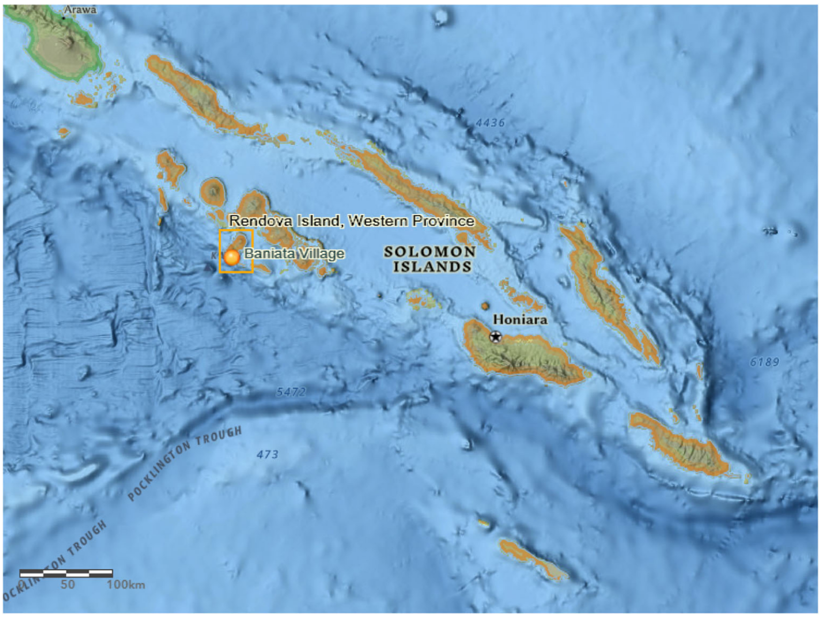


Fig. 1 Map of Baniata Village in Solomon Islands (Melanesia)*. *Map was created using ArcGIS® software by Esri*

an international multi-disciplinary research team. Ethical approval was obtained from the Massey University Human Ethics Committee (#4000019609) and research clearance from Solomon Islands Ministry of Education and Human Resources and Development (MEHRD) prior to commencing this study.

2.3 Data collection tools

2.3.1 Quantitative nutrition surveys

Nutritionist-administered surveys were used to collect quantitative data from participants using a snowball sampling technique. Inclusion criteria for the nutrition surveys were women aged 15–49 who were primarily responsible for growing, gathering, and preparing food for the household. Participants were excluded if they were pregnant or lactating, as their nutrient and energy needs are different from other adults (Butte & King, 2005). Households were randomly selected by first generating a list of all eligible households in the village, and then using the randomization function in excel. If households were unable or unwilling to participate, a new household was randomly selected. In total, 30 women were surveyed, representing over one-third of village households (38%). Data collection took place within the village of Baniata during the lean season in July and August 2018. Nutritionists walked to each selected household and conducted the survey within the home. The nutrition survey consisted of three sections: Anthropometry, Multiple pass quantitative 24-h dietary intake recalls, household food insecurity experience surveys (FIES), and nutrition related knowledge, attitudes and practices (KAP). The quantitative 24-h recall was repeated on a non-consecutive day. Anthropometrics were also measured, and included height, weight, and body fat percentage.

2.3.2 Anthropometry

Anthropometric measurements and socio-demographic data were collected prior to beginning the nutrition survey. Height (0.1 cm) was assessed using a tape measure, and each nutritionist was trained accordingly with best practices (CDC, 2011). Weight and body fat percentage (0.1 kg; 0.1%) were assessed using a bioelectric impedance digital weight scale (GreaterGoods™ Digital Body Fat Scale, Model 0391). BMI was calculated from the participants' height and weight (BMI = kg/m2).

2.3.3 24-h multiple pass recalls

Following the anthropometric measurements, nutritionists conducted repeat, 24-h multiple-pass recalls (24 h MPR) over two non-consecutive days to capture realistic dietary intakes of the women (Gibson et al., 2017) and to capture food biodiversity (species and varietal level information of foods consumed). In addition to the quantity of food consumed, the method of cooking, species and variety, and/or brand of foods were recorded. To conduct the 24 h MPR, participants were prompted to provide the actual food and drinks consumed the previous day, from waking up till retiring. If foods consumed were a mixed dish, nutritionists had participants identify each ingredient from the recipes and recorded the amount of each ingredient used to prepare the dish, as well as the total amount (volume) available after cooking. Actual food or drinks were available ~30% of the time for direct measurement. Portion sizes of actual foods and drinks were estimated by the participant and directly weighed using digital kitchen scales (Etekcity™ model EK6015) or measured using graduated cylinders (1000 mL). If the food or drink were not available for direct measurement, then participants estimated the portion sizes, quantity of ingredients used, and total cooked food amounts consumed using water, modelling clay or strips of paper in the original dishware. If clay or paper were used to determine portion sizes, nutritionists recorded volume displacement using graduated cylinders. After, food portions were estimated using density conversion factor estimates from the FAO/INFOODS Density Database (Charrondiere et al., 2012). Supplements and alcohol were probed for during the interview.

Participants were asked to identify the source of each ingredient; homegrown, purchased, or wild collected. Homegrown foods included foods that were intentionally managed by the household for consumption. Market purchased foods included any foods that were purchased from markets (formal or informal) or shops. Wild foods included any foods, which were not intentionally planted for consumption, and sourced from the wild including forests and the ocean.

2.3.4 Food insecurity

As food insecurity is often a driver of malnutrition, nutritionists administered the household Food Insecurity Experience Scale (FIES) (FAO, 2017). This eight-question item scale is designed to determine the level of household food insecurity experienced throughout the year for each household. These data were used in tandem with the qualitative food security data to triangulate the causes, timing and severity of food insecurity experienced by the villagers. The FIES is an indicator for SDG 2 (2.1.2).

2.3.5 Knowledge, attitudes and practices

Following FAO guidelines, a series of questions were asked assessing the participants' knowledge, attitudes, and practices (KAP) regarding nutrition (FAO, 2014) and adapted to also include food waste. The KAP questions were designed to identify specific barriers to accessing and preparing healthy foods. Data were analysed to identify how women's knowledge and attitudes influenced practices related to household food preparation. Post-harvest garden and household food waste was estimated by the primary cook of household, with primary foods and reasons for loss recorded.

2.3.6 Focus group discussions

A participatory rapid rural appraisal approach was designed to rapidly characterize and assess the resilience of Indigenous food systems through a series of structured discussions, using a guidebook prepared by an expert task force (SI 1). FGDs took place over the course of seven days and included participants of diverse age ranges and gender representation. Participatory FGDs were designed through a collaboration between Bioversity International and The Food and Agriculture Organization of the United Nations (UNFAO) as a part of the Indigenous Food Systems Initiative, *A Participatory Approach to Characterize and Access Resilience of Indigenous Food Systems to Strengthen Local Capacities and Inform Global Debates on Sustainability*. Topics included traditions and trends in the food system, sustainable natural resource use, exchange trade and marketing, climatic changes, food system governance, dietary diversity, food security, and young people's knowledge and perceptions. These topics aimed to summarize the inputs and outputs of the local food system and the influencing factors in terms of food production and distribution, human health and wellbeing, and environmental impacts. Through interactive discussions, the men and women FGDs independently constructed a timeline of food system transitions over the past century. Thematic analysis used the topology of food systems presented by Chase & Grubinger, 2014, while giving particular attention to the role of biocultural interactions and traditional knowledge.

A total of 14 participatory FGDs were held across a period of seven days and included a diverse representation of community members ($n = 86$), allowing for multigenerational insights into the challenges, strengths, and future projections regarding the sustainability of Baniata's Indigenous food system. Baniata community members – elders, women, men, and children – all have unique perspectives of the local food system with varying knowledge and responsibilities. Solomon Islands is a patriarchal society, therefore gender-specific focus groups ensured both men and women could comfortably respond to discussion questions. Open invitations were presented to all villagers for participation. Participants were organised into four focus groups based on age and gender to respect cultural gender differences and account for age-specific perspectives: men (aged 18–60; $n = 26$), women (aged 18–60; $n = 27$), two groups of mix-gendered children (aged 8–12 and 13–18; $n = 16$ and $n = 17$) respectively. Male and female adult focus groups hosted ~10 people each per session, with some attending multiple days. The two groups of children participated in an abridged one-day discussion. Focus groups were facilitated by the research team in Pidgin with the support of local scribes, fluent in the local languages, Pidgin and English, who were tasked with taking notes and translation. Point of redundancy was considered reached for each session when either a point of consensus was reached amongst the group and/or when no further contributions were made by participants. Each session was recorded with a microphone and reanalysed to ensure an accurate translation. Themes were extracted using a peer-reviewed structural format created by Bioversity International and the UN FAO.

2.3.7 Agrobiodiversity taxonomical identification

Species, breed and varietal identification was completed through a local team, including an agricultural specialist, expertise from Kastom Gardens Association (local conservation organisation) and the Baniata Village Elder. Species were identified to the varietal, cultivar or breed level where possible. When not possible, species were level identification was accepted. Taxonomy was verified using The Plant List[1] and The Catalogue of Life databases.[2]

2.4 Data analysis

2.4.1 Quantitative data analysis

Nutrition surveys, dietary data, and anthropometric measurements were analysed using IBM SPSS (Version 25), Tableau Public (Version 2018.2.2), Stata (Version 14.2), and Xyris FoodWorks (Version 9.0.3973). Nutritional composition data and food groups were sourced from the Pacific Island Food Composition Database (Version 2) (Dignan et al., 2004) and the FAO/INFOODS databases (FAO, 2018). Local foods which could not be identified in nutrition composition databases were substituted for comparable alternatives for the purpose of allocating a micronutrient profile for analysis. Usual were calculated using Multiple Source Method (MSM) (Harttig et al., 2011). Mean usual micronutrient intakes were compared with the estimated average requirements (EAR) (WHO and FAO, 2004). Usual intakes in this context are only valid for the lean season in which the data was collected, not for the entire year. The EAR estimates the average daily nutrient intake needed for half of the healthy population in a particular age and gender group. The EAR cut-point method was used to assess the proportion of participants whose usual nutrient intake falls below the EAR (National Academies Press, 2000).

Diet consumption data were categorized by the food groups outlined in the Pacific Island Food Composition Tables (v2) (Dignan et al., 2004). Ultra-processed foods were classified using the definitions outlined by the NOVA (1–4) method (Monteiro et al., 2019).

Four diet quality indicators were used to analyse dietary data.

1. Women's Dietary Diversity Score (WDDS) was used to determine the number of food groups women of reproductive age consumed from ten food groups, while the Minimum Dietary Diversity Score for Women (MDD-W) identified the proportion of women (aged 15–49) who consumed at least 15 g of food from at least five of the ten food groups (FAO, 2016). Diets that contain five or more food groups have a higher propensity for achieving micronutrient adequacy (FAO, 2016). The MDD-W was designed for use with women aged 15 to 49 years of age and serves as a proxy for the probability of micronutrient adequacy. The indicator was determined from the data collected during the 24-h dietary recalls and serves as a binary indicator of adequate dietary diversity.
2. Food Variety Scores (FVS) is a validated quantitative indicator for food intake, which can be used for cross-country data comparisons (Hodgson et al., 1994). FVS were calculated by counting the number of unique food items consumed.
3. Dietary species richness (DSR) (Lachat et al., 2018) is a count of the number of unique species that were consumed in the diet. DSR was extracted from the 24 h MPR data. This metric assesses both nutritional adequacy and food biodiversity, and has been validated for diets of women and children in rural areas during both wet and dry seasons.
4. Mean adequacy ratio (MAR) was calculated by summing the nutrient adequacy ratio (NAR) from ten nutrients (truncated at 100%), and then dividing by ten.

To demonstrate the relationship between the different diet quality indicators (DSR, DDS, FVS and MDD-W) and nutrition status, a linear regression analysis was run with these variables and body fat percentage, with $p \le 0.05$ regarded as significant. These results were also run controlling for adjusted energy intake.

Quantitative food insecurity experience scale (FIES) measures include two categories: moderate and severe. Raw scores (out of eight) between 4 and 6 were classified as moderate, and those between 6 and 8 were classified as severe (Smith et al., 2017).

2.4.2 Estimation of misreporting of dietary intake data

The proportion of possible over and under reporting was calculated comparing the participant's energy intake (EI) with their estimated basal metabolic rate (BMR_{est}) using the Harris-Benedict equations (Roza & Shizgal, 1984). The

[1] http://www.theplantlist.org/
[2] http://www.catalogueoflife.org/

equations used for women is (10 x weight in kg) + (6.25 x height in cm) – (5 x age in years) -161 x PAL (physical activity level). Goldberg cut-off points were applied using the ratio between EI and BMR_{est}. Under reporting was defined as EI: $BMR_{est} < 1.15$ and over reporting was defined as EI: $BMR_{est} > 1.96$ (Black, 2000).

2.4.3 Qualitative data analysis

Thematic analyses were structured from translated data into coding and classifications using the qualitative software NVIVO 12 (Version 12.1.1). Qualitative and quantitative food security data were analysed through across method triangulation (Bekhet & Zauszniewski, 2012) combining mixed methods data to enhance the analysis and interpretation of findings.

3 Results

3.1 Quantitative nutrition surveys

3.1.1 Participant characteristics

Mean age of the participants was 37.1 year (range: 18–50, *n* = 30), and the average household size was 6.46, typically consisting of a multi-generational family. Agri-food sales were the primary source of income for all participants and provided an average monthly household income between $500–1500 SBD ($63–188 USD). The majority of women (60%) were classified as overweight or obese, with a mean BMI of 26 (SD 4.9). Women had a median body fat percentage of 31.1% (SD 7.6) (Table 1).

Table 1 Household and participant sociodemographic characteristics (n = 30)

	n
Household characteristics (n=30)	
Annual incomes	
< $12,000 SBD (<$1470 USD)	18
> $12,000 SBD (>$1470 USD)	12
Household size	
Low (1–4)	7
Medium (5–9)	18
High (10–14)	5
Religion observed	
Seventh Day Adventist	12
Christian Fellowship Church (CFC)	18
Participant characteristics (n=30 women)	
Highest education received	
Primary school	25
Secondary school or higher	5
Drug usage (daily)	
Cigarettes	9
Betel nut	21
Alcohol	0
Ages of participant (year)	
Mean	37.1
Min	18
Max	50
Body Fat Percentage (%)	
Mean	30.1
Min	17.2
Max	43.1
Body Mass Index (BMI)	
Mean	26
Min	16.7
Max	35.1

3.1.2 Dietary intake

Mean MAR was found to be 0.70 (SD ± .16). Average macronutrient distributions indicated energy from fat (40%) was above the acceptable macronutrient distribution range for adults of 20–35%; energy from protein was low (9%), below the acceptable range of 10–35%; whilst energy from carbohydrate (51%) fell within the acceptable range of 45–65% of total energy intake.

Our data indicate that usual intakes of nutrients during the end of the lean season were significantly below the EAR (Table 2). Women who have inadequate intakes of essential nutrients include protein (53%), calcium (96.6%), vitamin B_1 (87%), vitamin B_2 (80%), vitamin A (80%), and fibre (76.7%). A half (52.3%) of women had a sodium intake above the WHO (2012) guidelines of >2 g/day. Energy intake was also slightly below average, with 63% of women consuming fewer calories than recommended. Estimation of misreporting at the group level via the Goldberg cut off points (1.44) indicated that no significant under- or overreporting occurred.

The macro and micronutrient contribution of homegrown, wild collected, and purchased (primarily imported) foods varied considerably per nutrient (Table 3). Most energy consumed came from homegrown foods (50.8%) followed by purchased foods (35.3%) and finally wild foods (13.9%). Commonly consumed homegrown foods included root vegetables, coconuts, bananas, cabbages, breadfruit and nuts. Only 13.3% of women met the WHO/FAO joint recommendation (FAO and WHO, 2004) to consume more than 400 g of fruits and vegetables per day (excluding starchy tubers and potatoes). Purchased foods constituted over a third (34.1%) of total energy intake, with ultra-processed (NOVA 4) foods contributing 11.3% of energy intakes. Top energy contributions from

Table 2 Usual nutrient intake of women in Baniata Village, Solomon Islands, calculated from 24-h multiple pass dietary recalls and compared to recommended intakes (n = 30)

	Mean	SD	% of women below EAR†	% women above recs ‡
Macronutrients				
Energy (kJ) ‡	7648	2540	63.3%	
Energy (Kcal)	1828	607	63.3%	
Total fat (g) *	79.8	35.4	–	76.7%
% total diet	*40.3%*			
Saturated fat (g)*	52.6	29.1	–	70%
Protein (g)	40.7	17.2	53.3%	
% total diet	*9.2%*			
Carbohydrates (g)	225	79.1	6.7%	
% total diet	*50.5%*			
Sugar (g)	61.1	20.7	–	66.6%
Fibre (g)	20.1	9.61	76.6%	
Micronutrients				
Vitamin A (μg)	347.8	394	80%	
Vitamin B_1 (mg)	0.63	0.37	86.6%	
Vitamin B_2 (mg)	0.61	0.36	80%	
Vitamin B_3 (mg)	20.5	8.42	13.3%	
Vitamin C (mg)	84.7	56.7	13.3%	
Na (mg) *	1934	842	–	53.3%
K (mg)	3204	1548	50%	
Ca (mg)	290.7	233	96.6%	
Mg (mg)	417	261	33%	
P (mg)	613	252	50%	
Fe (mg)	11.4	6.6	30%	
Zn (mg)	8.18	2.93	40%	

† Percentage of women below the estimated average nutrient requirements (EAR) for adults. Total fat, saturated fat, sugar, and sodium do not have an EAR for minimum quantity

‡ Energy requirements were compared to total energy expenditure (TEE) from BMR + PAL

*Total fat recommendations <30% total kcal and saturated fat recommendations <10% of total kcal (Hooper et al., 2015), Na recommendations <2000 mg (WHO, 2012)

NOVA 1–3 categories are white rice, tayio (canned tuna), and table sugar. Energy from NOVA 4 ultra-processed foods are sourced from noodles, biscuits, sugar sweetened beverages (Milo), and baked sweets. Whilst wild foods were a small contributor to the diet, they were micronutrient dense foods most commonly including ferns, opossums, fish, crabs, and shellfish.

Table 4 features the energy and macronutrient consumption percentages for each food group, as classified by the Pacific Islands food composition tables. Over 60% of mean daily energy intake came from just 3 main food types, primarily coconut products (that including flesh, milk/cream, and oil – 23.3%), roots and tubers (21.8%) and cereals and grains (mainly rice – 16.3%). Fish (mostly tinned) and bananas (desert and cooking) together made up just over 15% of total energy intake. Protein consumption was low (40.71 g ± SD 17.27), fish provided most of daily protein (32.3%), followed by cereals and grains (19.2%). Half of daily fat intakes came from coconut products, followed by fish (10.7%) and store- bought refined oils (11.1%).

Out of a score of 10, MDD-W ranged from two to six (average 4.18 SD ±0.96) and FVS averaged 7.5 (±SD 2.3). Over two-thirds (73%) of participants did not meet MDD-W, consuming fewer than five food groups. Starchy foods (roots, tubers and bananas) were the most commonly consumed food groups (97%) and were present in nearly every meal. Fish (90%), followed by dark leafy green vegetables (83%) were also commonly consumed, whereas pulses, eggs, and dairy were the food groups least likely to be consumed (17%, 7%, and 0%, respectively). There was a difference between the food groups consumed by those who reached MDD-W and those that did not (Table 5). In particular, from those that reached MDDW, fewer consumed grains (−25%) and replaced it with higher prevalence of consumption of nutrient rich foods, in particular nuts and seeds (+47% - mainly ngali nut), pulses (+28%), Vitamin A rich fruits (+26%), DGLV (+23%), fish and seafood (+14%), and meat and eggs (+8% for each).

Table 3 Macronutrient and micronutrient contributions from homegrown, wild collected, and purchased foods in Baniata Village, Solomon Islands (n = 30 women)

	Homegrown	Wild collected	Purchased NOVA 1–3*	Purchased NOVA 4*
Macronutrients				
Energy	51.7%	14.2%	22.8%	11.3%
Protein	34.9%	33.8%	22.3%	8.9%
Total fat	59.0%	23.2%	5.2%	12.6%
Saturated fat	64.3%	21.4%	3.5%	10.8%
Carbohydrates	48.5%	4.9%	35.3%	11.3%
Fibre	51.6%	9.3%	29.3%	9.8%
Micronutrients	73.4%	13.6%	8.4%	4.6%
Vitamin A	87.8%	11.4%	0.1%	0.7%
Vitamin B_1	60.5%	12.9%	8.5%	18.1%
Vitamin B_2	65.3%	16.6%	12.0%	6.2%
Vitamin B_3	45.7%	19.5%	26.3%	8.5%
Vitamin C	90.2%	9.1%	0.2%	0.5%
Na	17.9%	13.4%	57.3%	11.3%
K	78.9%	15.6%	2.8%	2.7%
Ca	79.0%	13.3%	4.4%	3.4%
Mg	68.4%	21.9%	7.5%	2.2%
Fe	62.1%	17.9%	6.0%	14.0%
Zn	38.9%	16.2%	36.9%	8.0%
Iodine	17.2%	14.2%	65.2%	3.4%

**NOVA classifications: (1) unprocessed and minimally processed foods (2) processed culinary ingredients (3) processed foods (4) ultra-processed foods*

Table 4 Energy and macronutrient consumption percentages of women in Baniata Village, Solomon Islands, grouped by Pacific Island food groups* (n = 30)

Food group	% Total energy (kJ)	% Total protein	% Total fat	% Total carbohydrates
Coconut products	23.3%	11.8%	50.3%	3.5%
Starchy veg (roots, tubers)	21.8%	11.7%	3.6%	35.9%
Cereals and grain products (rice)	16.3%	19.2%	1.3%	26.7%
Processed foods	10.5%	7.9%	11.1%	10.3%
Fish	7.4%	32.4%	10.7%	0.3%
Bananas	7.2%	3.4%	0.5%	12.3%
Fruits	4.3%	2.4%	7.7%	1.9%
Confectionary (inc. sugar)	4.2%	0.0%	0.0%	8.1%
Nuts and seeds	3.1%	5.1%	11.8%	0.4%
Seafood (non-fish)	0.5%	3.0%	0.5%	0.1%
Green vegetables	0.4%	0.8%	0.7%	0.3%
Fats and oils (exc. coconut)	0.4%	0.0%	0.9%	0.0%
Eggs	0.3%	1.3%	0.5%	0.0%
Vegetables	0.2%	0.3%	0.1%	0.2%
Legumes	0.1%	0.5%	0.0%	0.1%
Herbs, spices, sauces	0.1%	0.1%	0.1%	0.0%
Meat and poultry	0.1%	0.2%	0.1%	0.0%
Beverages	0.0%	0.0%	0.0%	0.0%

**Food groups were categorized in accordance with the Pacific Island food composition tables*

Table 5 Food group consumption patterns split by those who achieved minimum diet diversity scores of ≥5 compared with those who had scores <5 (n = 30)

	DDS<5 (n=22)	DDS≥5 (n=8)
Foods from grains	100.00%	75.00%
White roots, plantains, tubers	95.45%	100.00%
Pulses (beans, peas, lentils)	9.09%	37.50%
Nuts / seeds	40.91%	87.50%
Milk and milk products	0.00%	0.00%
Organ meat	0.00%	0.00%
Meat and poultry	4.55%	12.50%
Fish and seafood	86.36%	100.00%
Eggs	4.55%	12.50%
Dark green leafy vegetables	77.27%	100.00%
Vit a rich roots/tubers	22.73%	25.00%
Vit a rich fruits	9.09%	25.00%
Other vegetables	22.73%	12.50%
Other fruits	81.82%	87.50%

The agrobiodiversity of foods reported to be consumed by participants included 39 different species and, in total, 99 different varieties and breeds (Table 6). This does not include purchased processed foods with more than one ingredient. Food groups with the greatest species richness found to be consumed were roots, tubers and bananas (33), seafood (23), dark green leafy vegetables (11), fruits (11), non-leafy vegetables (7), nuts and seeds (4), legumes (3), eggs (2), animals (2), and 1 grain (white rice). Average DSR was 12.1 (SD 3.4). DSR was statistically significantly positively correlated with MAR (Coef. 0.039, $p < 0.05$,).

The strength of the inverse associations between DSR, FVS, DDS and body fat percentage were weak (−0.205, 0.231 and 0.251 respectively) but statistically significant ($p = 0.012$, 0.004, and 0.007 respectively) (Fig. 2). These associations were still evident and significant after controlling for energy intake (SI 2). MAR was not significantly related to body fat percentage (Coef −4.93, $p = 0.402$). Reported levels of income did not show significant association with body fat percentage. More food secure households were associated with higher body fat percentages, though not significant. Knowledge attitudes and practices towards the importance of fruits and vegetable consumption were generally low (Table 7).

3.1.3 Household food insecurity experience scale

Household food insecurity was seasonally variable, with villagers experiencing the highest self-reported rates during the lean months of May, June and July. Of the 30 households surveyed, 48% were moderately food insecure, and 10.3% were severely food insecure, primarily during the lean season. Results from the FIES indicated that throughout the year due to lack of money or other resources: 83% of households were worried they would not have enough food; 77% ate less than they thought they should; 60% ate fewer types of foods; 57% were unable to eat healthy foods and/or were hungry and did not eat; 42% skipped a meal; 28% ran out of food; and 4% went an entire day without eating.

3.1.4 Food wastage and preservation

Participants estimated that 27% of all food was wasted via either post-harvest losses or household losses. Top factors for food waste included cooking too much food (87%), over collection of foods (67%), did not use in time (63%), too much grown (57%), or forgot/did not want to use (23%). The most commonly wasted foods were roots/tubers (90%), vegetables (50%), fruits (43%), and nuts/seeds (13%). Negligible amounts of meat or fish was wasted. Food scraps were often left for free-roaming chickens and hogs to forage or discarded with trash. Very little food waste was composted or returned to the gardens for nutrient recycling.

Food preservation was limited to dried ngali nuts and smoked fish. Most households (87%) processed and dried ngali nuts for household consumption and agri-food sales. A small number of households practised smoking fish for preservation (23%). No other food preservation techniques were reported.

3.2 Qualitative participatory focus group discussions

3.2.1 History of food system transitions

Food system transitions away from traditional diets were reported (by men and women) to begin as early as the 1920's during visits from Seventh Day Adventist missionaries (Fig. 3). As an example, Seventh Day Adventism prohibits the consumption of certain foods, such as pigs, possum, molluscs, and crustaceans. Dietary shifts again occurred during World War II (WWII) when American and Japanese soldiers were living amongst the villagers. One Baniata woman explained that *"dietary changes occurred following WWII when the war was over and remaining rations were shared among the villagers".* These rations consisted of packaged noodles, canned meats, and sugar. During the 1970's, it was reported that the Solomon Islands government provided subsidies for villagers to increase production of coconuts for agri-food income generation opportunities. In the late 1970s, Solomon Tayio limited, a large tuna processing facility, opened for production in Noro town, located around two hours from the village by boat. Once established, diets were said to begin transitioning from fresh fish to canned Solomon tayio (tuna) due to ease of access and affordability.

The most dramatic dietary transitions were reported by the elders to have occurred within the past 2–3 decades. One man

Table 6 Agrobiodiversity data informed by focus group discussions in Baniata Village, Solomon Islands

Crop species	Common English Name	Local name	Description	Consumed in 24 h MPR
Roots and Tubers				
Alocasia macrorrhiza (L.) Schott	Giant Taro	Ozo	White flesh	
Alocasia macrorrhiza (L.) Schott	Giant Taro	Ozo	Dark red/pink flesh	
Colocasia esculenta (L.) Schott	Taro	Fivo/Buini	–	
Colocasia esculenta (L.) Schott	Taro	Mahio	–	
Colocasia esculenta (L.) Schott	Taro	Omu	–	X
Colocasia esculenta (L.) Schott	Taro	Ruta	–	
Colocasia esculenta (L.) Schott	Taro	Sisiri	–	
Colocasia esculenta (L.) Schott	Taro	Sofu	–	
Cyrtosperma merkusii (Hassk.) Schott.	Swamp Taro	Kakake	–	X
Dioscorea alata L.	Greater Yam	Purple Yam	Purple flesh	X
Dioscorea alata L.	Greater Yam	White Yam	White flesh	X
Dioscorea esculenta (Loureiro) Burkill	Pana or Lesser Yam	Finorusu	–	
Dioscorea esculenta (Loureiro) Burkill	Pana or Lesser Yam	Fivo pana	Purple flesh	X
Dioscorea esculenta (Loureiro) Burkill	Pana or Lesser Yam	Susa	–	
Dioscorea esculenta (Loureiro) Burkill	Pana or Lesser Yam	Ulawa	–	
Dioscorea rotundata Poir	Greater Yam	Vanuatu Long	–	
Dioscorea rotundata Poir	Greater Yam	Vanuatu Short	–	
Dioscorea spp.	Greater Yam	Butterfly Yam	White flesh	X
Dioscorea spp.	Greater Yam	Hero Yam	Red and white flesh	
Dioscorea spp.	Greater Yam	Hoahoa	–	
Dioscorea spp.	Greater Yam	Riseboy	Purple flesh	
Dioscorea spp.	Greater Yam	Snake Yam	White flesh	
Dioscorea spp.	Greater Yam	Tonga yam	–	
Dioscorea spp.	Greater Yam	Vaka Yam	White flesh	
Dioscorea spp.	Greater Yam	Vero	–	X
Dioscorea spp.	Pana or Lesser Yam	Bou	–	
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Atoifi	Red skin, yellow flesh	X
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Benimala	Purple flesh	
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Ema Duri	Yellow flesh	X
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Fivomahu	–	
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Meleke	Purple flesh	X
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Nimbi	–	
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Taeveke	Red skin, white flesh	X
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Taumahu	–	
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Temarae	White flesh	X
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Two Months	–	
Ipomoea batatas (Linnaeus) Lam.	Sweet potato	Vaero	Light yellow flesh	
Manihot esculenta Crantz	Cassava	Fizi	White flesh	
Manihot esculenta Crantz	Cassava	Green Top	–	
Manihot esculenta Crantz	Cassava	Kaiza	–	X
Manihot esculenta Crantz	Cassava	Pencil Cassava	White flesh	X
Manihot esculenta Crantz	Cassava	Ranoga	–	X
Manihot esculenta Crantz	Cassava	Six Months	White flesh	
Manihot esculenta Crantz	Cassava	Underpant	White flesh	X
Manihot esculenta Crantz	Cassava	Yellow Curry	Yellow flesh	X
Xanthosoma sagittifolium (L.) Schott	Chinese Taro	Karuver	White flesh	X
Xanthosoma sagittifolium (L.) Schott	Chinese Taro	Karuvera	Pink flesh	X

Table 6 (continued)

Crop species	Common English Name	Local name	Description	Consumed in 24 h MPR
Zingiber officinale Roscoe	Ginger	Tuva Migori	White flesh	X
Zingiber officinale var. Rubrum Theilade	Ginger	Aro Migori	Red flesh	X
Banana				
Musa sp (A &/or B genome) cv.	Banana	Bo'o	White flesh	
Musa sp (A &/or B genome) cv.	Banana	Bougainville	White/yellow	X
Musa sp (A &/or B genome) cv.	Banana	Gatokae		X
Musa sp (A &/or B genome) cv.	Banana	Hiomo	–	
Musa sp (A &/or B genome) cv.	Banana	Misisi	Yellow flesh	
Musa sp (A &/or B genome) cv.	Banana	Napoti	Yellow flesh	X
Musa sp (A &/or B genome) cv.	Banana	Pohara	White flesh	X
Musa sp (A &/or B genome) cv.	Banana	Rabaul	–	
Musa sp (A &/or B genome) cv.	Banana	Richard	–	X
Musa sp (A &/or B genome) cv.	Banana	Twistie	–	X
Musa sp (A &/or B genome) cv.	Banana	Uvi	Yellow flesh	X
Musa sp (A &/or B genome) cv.	Banana	Vasara	Yellow flesh	X
Musa sp (A &/or B genome) cv.	Banana	Wasara Vahu		X
(Musa spp)	Banana	Fiji Vahu	Yellow flesh	X
(Musa spp)	Banana	Nuguru	–	X
(Musa spp)	Banana	Pedi Vahu	–	
(Musa spp)	Banana	Sikaiana Vahu	–	
(Musa spp)	Banana	Sweet Banana	Yello and white flesh	X
(Musa spp)	Banana	Zario Vahu	–	
Fruit				
Ananas comosus (L.) Merr.	Pineapple	Pineapple	Brown skin, yellow flesh	
Ananas comosus (L.) Merr.	Queen Pineapple	Pineapple	Brown skin, yellow flesh	
Annona muricata L.	Soursop	Soursop/omo	Green skin, white flesh	X
Artocarpus altilis (Parkinson) Fosberg	Breadfruit	me'u	Green flesh	X
Averrhoa carambola L.	Carambola	Starfruit	Yellow skin, pale flesh	X
Bruguiera gymnorhiza (L.) Lam.	Mangrove fruit	Fetu		X
Burckella obovata (G.Forst.) Pierre	Burckella	Sohvao	Green outer skin and yellow flesh	
Unidentified	Unidentified	Voh	Yellow outer skin and white flesh	
Carica papaya L.	Pawpaw/Papaya	Mango - Paw paw	Orange flesh	X
Carica papaya L.	Pawpaw/Papaya	Melon – paw paw	Red flesh	
Carica papaya L.	Pawpaw/Papaya	Paw paw	Yellow skin	X
Citrullus lanatus (Thunb.) Matsum. & Nakai	Watermelon	Melon	Yellow and red flesh, long	
Citrullus lanatus (Thunb.) Matsum. & Nakai	Watermelon	Melon	Red and yellow flesh, round	
Citrus aurantium L.	Sour Orange	Half Orange	Orange flesh	
Citrus grandis (L.) Osbeck	Pomelo	Pomolo	White flesh	
Citrus grandis (L.) Osbeck	Pomelo	Pomolo	Pink flesh	X
Citrus grandis (L.) Osbeck	Pomelo	Pomolo	–	X
Citrus reticulata Blanco	Mandarin	Madarin	Orange flesh	
Citrus sinensis (L.) Osbeck	Orange	Sweet orange	Orange flesh	
Cocos nucifera L.	Coconut	Coconut	Green skin	X
Magnifera indica L.	Mango	Mango	Light yellow or White flesh, wild	
Magnifera indica L.	Mango	Mango	Orange flesh, common	

Table 6 (continued)

Crop species	Common English Name	Local name	Description	Consumed in 24 h MPR
Nephelium lappaceum L.	Rambutan	Rambutan	White flesh	
Persia americana Mill	Avocado	Avocado	Green flesh	
Pometia pinnata J.R.Forst. & G.Forst.	Pacific Lychee	Gema fruit	–	
Psidium guajava L.	Guava	Guava	Pink flesh, local, small	X
Psidium guajava L.	Guava	Guava	White flesh, big, long	X
Psidium guajava L.	Guava	Guava	Pink flesh, big, round	
Spondias cytherea Sonn	Golden apple	Encori or opiti	White and yellow flesh	
Syzygium aqueum (Burm.f.) Alston	Watery rose apple	Kapicala	PNG	
Syzygium malaccense (L.) Merr. & L.M.Perry	Malay apple	Kapicala	Big/small	
Syzygium malaccense (L.) Merr. & L.M.Perry	Malay apple	Kapicala	Wild	
Beans and Legumes				
Arachis hypogea L.	Peanut	Peanut	White, flat	
Arachis hypogea L.	Peanut	Peanut	Red	
Arachis hypogea L.	Peanut	Peanut	Purple	
Arachis hypogea L.	Peanut	Peanut	White	
Arachis hypogea L.	Peanut	Peanut	Red	X
Benincasa hispida (Thunb.) Cogn.	Wax Gourd	Waku bean	Big white, round	
Psophocarpus tetragonolobus (L.) DC.	Wing bean	Butterfly bean	–	
Trichosanthes cucumerina L	Snake gourd	(Cocoa) Snakebean	Cocoa, short and wide	X
Trichosanthes cucumerina var. anguina L.	Snake gourd	Snakebean	Striped body, Army	X
Vigna unguiculata subsp. sesquipedalis (L) Verdic	Purple YardLong Bean	Rigiti Bean	Purple	
Vigna unguiculata subsp. Sesquipedalis (L) Verdic	Striped YardLong Bean	Rigiti Bean	Army	X
Vigna unguiculata subsp. Sesquipedalis (L) Verdic	YardLong Bean	Rigiti bean	Black bean / seeds	
Vigna unguiculata subsp. Sesquipedalis (L) Verdic	YardLong Bean	Rigiti bean	Small	X
Vigna unguiculata subsp. Sesquipedalis (L) Verdic	YardLong Bean	Green bean	Long	
Vigna unguiculata subsp. Sesquipedalis (L) Verdic	YardLong Bean	Waku bean	Long, large/thicker pod	
Vigna unguiculata var. unguiculata	Cowpea or dwarf bean	Cowpea bean	dwarf	
Dark Green Leafy Vegetables				
Abelmoschus manihot (L.) Medic.	Hibiscus/Slippery cabbage	Slippery cabbage - noodle		X
Abelmoschus manihot (L.) Medic.	Hibiscus/Slippery cabbage	Slippery cabbage – Tsunami		X
Abelmoschus manihot (L.) Medic.	Hibiscus/Slippery cabbage	Slippery cappage - maruana		
Allium cepa var. aggregatum L., G.Don.	Spring onion/Bunching onion	Shallot		X
Brassica campestris L.	Saladeer	Saladia		
Brassica rapa L.	Chinese cabbage	Paksoi		X
Brassica rapa L.	Choy sum	Choy sum		
Colocasia esculenta (L.) Schott	Taro leaves	Taro leaves – Atiefaro		X
Colocasia esculenta (L.) Schott	Taro leaves	Taro leaves - Faro		
Colocasia esculenta (L.) Schott	Taro leaves	Taro leaves - Omu		X
Cucurbita maxima Duch ex Lam.	Pumpkin leaves	Pumpkin leaves		X
Cyathea hornei (Baker) Copel	Fern	Savita		
Diplazium esculentum Swartz	Fern	Puha		

Table 6 (continued)

Crop species	Common English Name	Local name	Description	Consumed in 24 h MPR
Acanthurus nigricauda Duncker & Mohr, 1929	Epaulette surgeonfish	Evaeva		
Acanthurus nigrofuscus (Forsskål, 1775)	Brown Tang (Surgeon fish)	Asirae		
Acanthurus xanthopterus Valenciennes, 1835	Yellow fin Surgeon fish	Tavazi		
Anadara antiquata (Linnaeus, 1758)	Antique Ark (Bivalve)	Deo		
Anguilla marmorata Quoy & Gaimard, 1824	Giant mottled eel	Eelfish		
Atactodea striata (Gmelin, 1791)	Striate beach clam	Kenekene		
Balistidae	Triggerfish	Fubua		
Balistoides viridescens	Titan triggerfish	Makoto		
Birgus latro (Linnaeus, 1767)	Coconut crab	Coconut crab		X
Bolbometopon muricatum (Valenciennes, 1840)	Humphead Parrot fish	Topa		
Cambarus spp.	Freshwater lobster	Crayfish		
Caranx spp.	Trevally	Mamula		X
Caulerpa lentillifera (J.G. Agardh, 1837)	Sea grapes	Seaweed		
Cerithidea quadrata G. B. Sowerby II, 1866	Black chut-chut	Ropi		
Chelonia mydas (Linnaeus, 1758)	Green sea turtle	Sea turtle		X
Dermochelys coriacea (Vandelli, 1761)	Leatherback turtle	Turtle		
Elagatis bipinnulata (Quoy & Gaimard, 1825)	Rainbow runner	Rainbow (Babalu)		
Encrasicholina punctifer Fowler, 1938	Buccaneer anchovy	Eoea		
*Epinephelus hexagonatus (*Forster, 1801)	Starspotted grouper	Orufu		X
Epinephelus lanceolatus (Bloch, 1790)	Giant Grouper	Zoata		
Epinephelus spp	Round head grouper	Bukulu		
Etelis spp.	Deep water snapper	Noto		
Gazza achlamys Jordan & Starks, 1917	Smalltoothed ponyfish	Sogari		
Halichoeres argus (Bloch & Schneider, 1801)	Angus wrasse (Very slippery)	Zaoto		
Istiophoridae	Marlin	Viviru		
Katsuwonus pelamis (Linnaeus, 1758)	Skipjack Tuna	Bonito		X
Kuhlia marginata (Cuvier, 1829)	Dark-margined flagtail (River fish)	Hegosune		
Lethrinus miniatus (Forster, 1801)	Sweetlip emperor	Mihu		
*Macrobrachium lar (*J.C.Fabricius, 1798)	Prawn/shrimp	Prawn	Freshwaster	
Myripristis spp.	Soldier fish	Fufu		X
Naso brevirostris (Cuvier, 1829)	Canvass or Unicorn fish	Fagu		
Octopus cyanea Gray, 1849	Octopus	Octopus		
Philypnodon grandiceps (Krefft, 1864)	Olive flat head gudgeon	Begozo		
Pinctada margaritifera (Linnaeus, 1758)	Oyster	Riki		X
Plectorhinchus lineatus (Linnaeus, 1758)	*Yellowbanded sweetlips*	Fehu		
Pseudomyxus capensis (Valenciennes, 1836)	Freshwater mullet	Embo		
Sardinella spp.	Sardines	Katukatu		
Sargocentron tiereoides (Bleeker, 1853)	Pink Squirrel fish	Heta		X
Scaridae or Scarus spp.	Parrot fish	sioura		
Scomberoides lysan (Forsskål, 1775)	Doublespotted queenfish	Eusava, lasilasi		
Scomberomorus cavalla (Cuvier, 1829)	Spanish mackerel	Kingfish		
*Scylla serrata (*Forskål, 1775)	Mud crab	Kapehe		X
Sepioteuthis lessoniana d'Orbigny, 1826	Reef Squid	Squid		

Table 6 (continued)

Crop species	Common English Name	Local name	Description	Consumed in 24 h MPR
Siganus corallinus (Valenciennes, 1835)	Blue-spotted spinefoot (Yellow reef fish)	Gore		X
Siganus lineatus (Valenciennes, 1835)	Golden-lined spinefoot	Sirusiru		
*Sphyraena barracuda (*Edwards, 1771)	Pinkhandle or Obtuse Barracuda	Gohi		X
Thunnus albacares (Bonnaterre, 1788)	Yellowfin tuna	Tatalingi		X
Toxotes jaculatrix (Pallas, 1767)	Archer fish	Vavanaka		
Trachinotus baillonii (Lacepède, 1801)	Small spotted dart	Dalo		
*Tylosurus crocodilus (*Péron & Lesueur, 1821)	Houndfish or Needlefish	Somasoma		
Egg				
Anas superciliosa Gmelin, 1789	Egg	Duck egg		
Birgus latro (Linnaeus, 1767)	Egg	Coconut Crab egg		
Chelonia mydas (Linnaeus, 1758)	Egg	Turtle egg		
Dermochelys coriacea (Vandelli, 1761)	Egg	Leathback turtle egg		X
Ducula pistrinaria Bonaparte, 1855	Egg	Dove egg		
Ducula rubricera (Bonaparte, 1854)	Egg	Dove egg		
Gallus gallus (Linnaeus, 1758)	Egg	Chicken egg		X
Megapodius eremita Hartlaub, 1868	Egg	Megapode egg		
Panulirus penicillatus (Olivier, 1791)	Egg	Crayfish egg	common	
Porphyrio porphyrio (Linnaeus, 1758)	Egg	Rednose Bird egg		
Unidentified	Egg	Fish egg		
Unidentified	Egg	Punder egg		

from the focus group shared: "*Before, we use to eat more local foods such as taro, yam, pana, and banana. Now, more of the foods in our diet are processed because they are easy to get and very fast to cook.*" The most recent and reportedly profound shift was due to tree loggers working near Baniata in the 1990s, introducing the villagers to even more imported foods than before. Another man agreed, adding, "*Villagers are no longer as interested in local foods because they take time to cook, unlike processed foods [which] are easier to cook and require less firewood.*"

Local villagers were beginning to experience increased rates of NCDs such as heart disease, high blood pressure, and diabetes. According to one woman in the focus group: *"Diet changes that are currently happening will result in unhealthy people in the village, since now we start to see some people are sick and not strong. There is an increase in shortness of breath, belly aches, muscle weakness, and sick feelings from eating processed foods."*

3.2.2 Food system changes

According to village elders, Baniata's traditional and current agricultural system is entirely organic, as it does not rely on any external agri-chemical inputs (synthetic fertilizers, pesticides, herbicides, and fungicides). However, pests and diseases are reported to be increasing, including rat infestations. Garden productivity was perceived to be decreasing due to climate change, pests, increased land pressures, and decreased fallowing times. Climate changes identified include increasingly inconsistent seasonal weather patterns and more intense periods of heavy rains. These weather changes are challenging Indigenous agricultural practices which have been utilised for centuries.

Climate change related weather patterns were described by the villagers as becoming "more intense" and "more frequent", adding increased stress to food production. One villager noted, "s*ince the 1990s, more frequent natural disasters occur*". Villagers have previously understood weather patterns and prepared for cyclones around December. One man stated, "n*ow, cyclones are much more difficult to predict".* Stronger storms and heavier rains are causing increased flooding that "*destroys gardens*" and "*creates landslides that block rivers*". Villagers also reported that increased rains are washing away soils and giving rise to increases in crop pests and diseases. Knowledge regarding planting seasons, fishing patterns, and crop harvests are being challenged. Water quality and security was reported as a non-issue.

3.2.3 Economic and social development

Household incomes were predominantly generated through the sale of agri-food products at regional produce markets in the towns of Munda and Noro. All villagers sell agri-food

Table 7 Knowledge, attitudes and practices (KAP) survey results from Baniata Village, Solomon Islands (n = 30 women)

Knowledge	2 correct responses	1 correct response	No correct response
Can you identify two health issues from being overweight or obese?	60%	26.6%	13.3%
Can you share two reasons why someone might be overweight?	56.6%	26.6%	13.3%
Can you name two benefits of eating fruit?	39.8%	50.0%	10.2%
Can you name two foods rich in Vitamin A?	33.3%	63.3%	3.3%
Attitudes	**Disagree**	**Neutral**	**Agree**
I am satisfied with my food choices	6.7%	3.3%	90%
Fruit and vegetables are expensive to purchase	43.3%	16.7%	40%
It's important to prepare a wide variety of foods	6.7%	3.3%	90%
It's challenging to prepare a wide variety of foods	40.4%	17.2%	42.4%
It is important to provide fruits and vegetables for my family	6.7%	0%	93.3%
It is important to provide meat for my family	23.3%	36.7%	40%
It is important to provide many fish for my family	3.3%	26.7%	70%
It is difficult to get my children to eat fruits and vegetables	60%	10%	30%
Practices			
Do you read nutrition facts labels?	**Yes**	**Sometimes**	**Never**
	3.3%	53.5%	43.3%
Do you practice food preservation techniques?	**Drying**	**Smoking**	**None**
(can provide more than one response)	86.6%	23.3%	13.3%

products for consumption and sale at markets. Accessing these markets requires a 90-min petrol-powered commute by sea from Baniata. Travel time in combination with year-round humidity and high temperatures (~30 °C) creates quality challenges for agri-food market sales. Primary agri-food products for sale at local and regional markets included homegrown yams, cassava, taro, sweet potatoes, bananas, fruits, green leafy vegetables, nuts, and less frequently – fresh fish. Two agri-food products were also sold in larger quantities in national or international markets: copra (dried coconut) used to produce coconut oil and locally processed dried ngali nuts (*Canarium indicum L.*).

Baniata villagers identified several barriers to market access and income generation. The cost of petrol is high in relation to incomes, creating an economic barrier to market access given the amount of fuel required to access the central market. Market access is limited during certain seasons due to the small size of the boat used and rough seas. The lack of adequate storage and refrigeration causes agri-food products to lose quality in the hot, humid environment; both during the commute and throughout the day at the markets. Lastly, higher numbers of vendors are selling their goods at the markets, creating a larger supply causing lower prices and sales. However, the women reached consensus that most families were generating enough income to provide for essential daily activities, which include purchasing food, goods and housing materials from outside of the community, and children's school fees. Trading of goods between communities and villagers was also reported, but this tradition is declining as cash is increasingly prioritized.

3.2.4 Food and nutrition security

Men and women agreed, as incomes rise so does the purchasing of imported foods from shops outside of Baniata. One female focus group participant shared that *"traditional crops are increasingly sold for [store-bought] items, [such as] white rice, sugar, biscuits, soap (for body and clothes), and salt"*. Disagreement existed between the men and women on how quickly the nutrition transition was occurring, however both men and women shared fears that their Indigenous food system is being threatened.

Seasonal fluctuations in food availability limits the number of foods available during certain periods of the year. In periods of low food availability, imported rice is an increasingly preferred food source due to its convenience, taste and low cost. However, one woman stated, "*rice does not keep us full as long as kumara* (sweet potato; *Ipomoea batatas*)*, and we get hungrier more quickly when working in the gardens"*.

Seafood catches were also reported to be in decline. Men stated that "*fish is declining as it is not easy to catch fish nowadays, indicated by the length of time to go fishing, distance to walk or paddle to do fishing"*. Older men reported fewer fresh fish in their diets from when they were younger. Another man added *"even in the rivers, there used to be plenty of fish and eels. Nowadays both fish and eels have declined,*

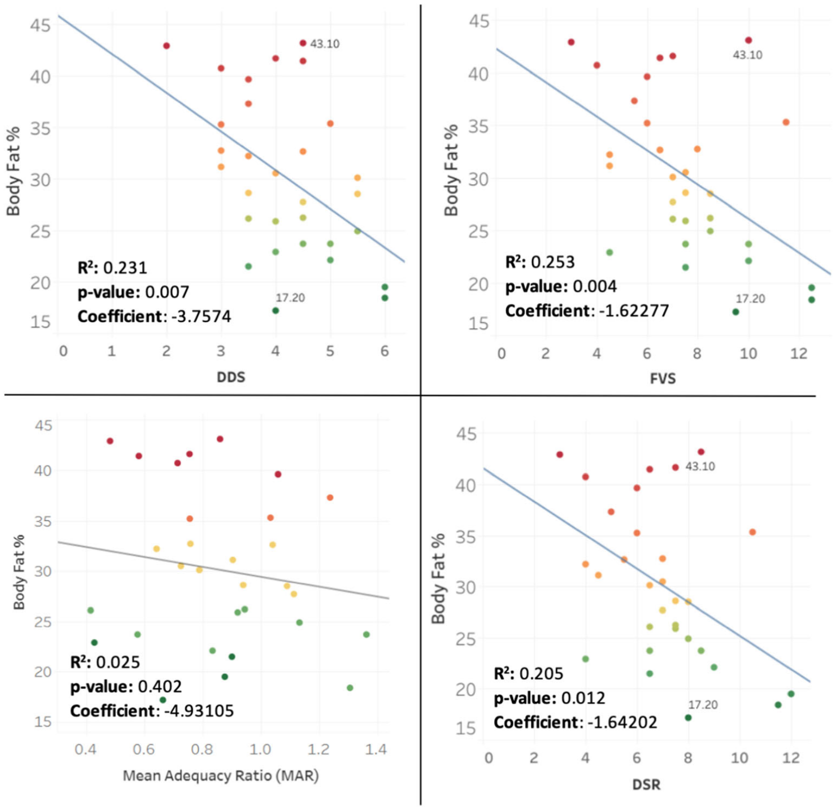


Fig. 2 Four dietary diversity and diet quality indicators compared with body fat percentages in Baniata Village, Solomon Islands ($n = 30$ women). *The four diet diversity indicators used for comparison with body fat percentage were: dietary diversity score (DDS), food variety score (FVS), mean adequacy ratio (MAR), dietary species richness (DSR)*

probably due to increased human population as well as flooding that washed the eels out to the sea".

3.2.5 Utilization of local agrobiodiversity

Collectively, men and women identified 221 species and varieties that were previously or currently available for use as foods within the local landscape. These foods were categorized by homegrown and market foods (63%) or wild foods (37%). Of these species and varieties 67 were roots, tubers, or bananas, 51 seafood, 26 dark green leafy vegetables, 25 fruits and vegetables, 16 legumes, 14 animals, 12 eggs, and 10 nuts and seeds (Fig. 4, Table 6).

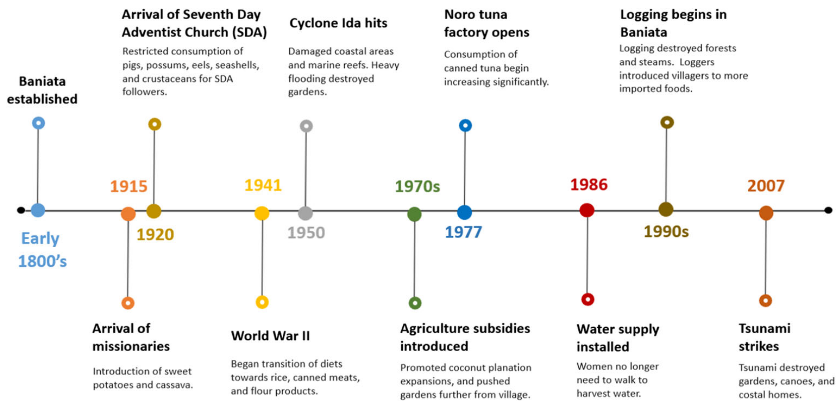


Fig. 3 Food system transition timeline from focus group discussions in Baniata Village, Solomon Islands

Focus group participants came to the consensus that traditional knowledge and utilization of local agrobiodiversity is rapidly declining. Both men and women focus groups outlined how traditional language, hunting and fishing techniques, food preparation traditions, and utilization of local agri-food biodiversity is being lost due to the increased reliance and consumption of imported foods. *"Foods in the past are very good and healthy and make the body stronger but now, local foods are not always eaten and our health is decreasing compared to the past."*

The transferring of traditional knowledge is exclusively an oral custom, which typically occurs during gardening and cooking for women, and during hunting and fishing for men. Village elders used to teach young boys how to hunt and fish, and while doing so, they share stories, traditions, and biodiversity utilization knowledge. Similarly, women would teach girls how to garden, prepare meals, and conduct household chores. Both groups of men and women were largely convinced that their children are uninterested in learning the traditional ways of life, stating that children view modern lifestyles as being more appealing. Contradicting these views, the majority of adolescent and children's FGD participants (94%), expressed a strong interest in continuing traditions such as gardening, fishing, collecting wild foods, and raising a family in the village.

While there is interest by both the men and women of Baniata to preserve traditional foods and recipes, when prompted about the future of their food system, villagers projected that *"in 20-year time, we might still eat our own kind [of food] since we are still practising how to collect them, but not frequent like now unless we start doing something to look after our local varieties and breeds".*

3.2.6 Youth food system perspectives

Youth FGDs explored the role of boys and girls in the local food system, their dietary preferences, and aspirations for the future. Boys still took part in hunting and fishing with their fathers, whereas girls helped garden and cook. When asked about the future, most of the youth (82%) expressed interest in taking over the family farm when they get older. The minority (18%) wanted to leave the village to attend university and/or get married, and then eventually return to Baniata.

When prompted, youth were able to differentiate between traditional and imported foods. The majority of youth participants shared their enjoyment towards eating traditional foods, their favourites being mangos, cabbage, bananas, jackfruit, coconuts, paw paws, ngali nuts. Many also expressed their affinity towards imported foods such as white rice, noodles, cheese puffs, and sweetened biscuits. Looking towards the future, most (75%) agreed that they wanted to continue eating traditional foods as well as imported foods.

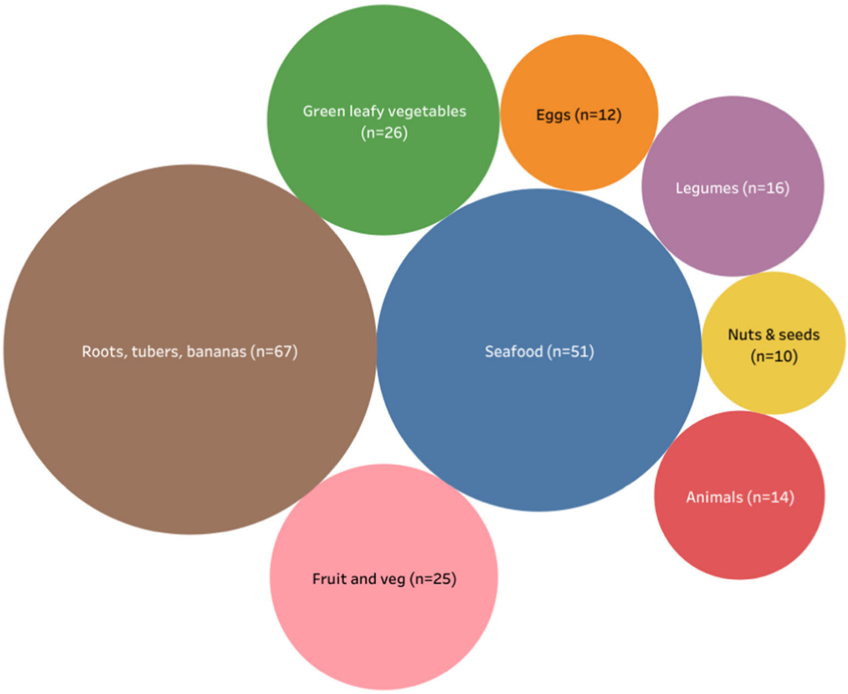
4 Discussion

Our study examined dietary intakes among Indigenous Solomon Islanders in a remote rural community using repeat 24 h MPRs and found dietary intakes of several essential nutrients to be insufficient. Additionally, macronutrients were unbalanced when compared to the recommended macronutrient range as a percent of total energy. Energy intakes included large amount of fat (primarily from coconut products), which was overconsumed by over three quarters of women. Saturated fat intakes exceeded recommendations by 70%. Whilst fat intakes are an important contributor to maintaining recommended energy intakes within the lean seasons, these are likely habitual fat intakes throughout the year which is attributing to the overweight and obesity rates. More than half (53%) of women had protein intakes below EAR, despite most women consuming some form of fish or seafood. Other sources of protein such as meat, poultry, eggs and legumes were not widely consumed. Fibre intakes were below recommendations, likely attributed to the increasing trend of substituting traditional staples of roots and tubers high in fibre, with low fibre white refined rice, together with low of fruit and vegetable consumption.

Several micronutrients were inadequately consumed. The majority of women had inadequate intakes of calcium (97%) and zinc (40%), likely linked to the limited quantities of animal source foods consumed, exasperated by low consumption and diversity of the diet. Dairy products which are high in calcium are not traditionally part of the diet, nor were they consumed. Promotion of local foods high in calcium, such as dark green leafy vegetable, could help improve calcium and overall micronutrient intakes. However, it is important to note, that over two-thirds of participants reported betelnut use, which is common practice in Solomon Islands and across the Pacific. Betelnut is combined with ground reef coral (calcium carbonate; CaCO3) to produce an intoxication effect. Coral may supply dietary calcium, however betelnut is classified as a Group 1 carcinogen by the International Agency for Cancer Research, and its use should not be encouraged. Cases of hypercalcemia have been reported from heavy users of betelnut (Lin et al., 2002). Insufficient vitamin A intakes were likely due to insufficient intake of foods rich in beta-carotene such as papaya, mango, Fe'i banana and orange sweet potatoes despite these being available. Another contributing factor is also likely the transition away from the catching and consumption of wild small fish, traditionally consumed whole, which contain high quantities of vitamin A in the eyes and organs, as well as calcium in the bones.

Participants who consumed higher number of plant and animal species had a significantly higher probability of meeting nutrient recommendations (MAR) and a lower body fat percentage. The mechanism behind lower body fat percentages may involve a substitution effect by displacing energy-

Fig. 4 Available agrobiodiversity organised by food group in Baniata Village, Solomon Islands ($n = 221$)



dense and nutrient-poor ultra-processed foods with increased healthy and diverse foods (Poti et al., 2017). Additionally, consuming more fruits and vegetables has been associated with improved health outcomes including lower body fat percentages (He et al., 2004). Evidence is clear that higher body fat percentages are linked to increased cardiovascular disease and other NCD risks (Lee et al., 2011). Variability between species diversity and body fat percentage were high, but significant. Though the sample size was small, our findings provide some evidence that consuming an increased diversity of minimally processed species may contribute to a lower body fat percentage (Asghari et al., 2017). However, ensuring macronutrient and energy balances are important considerations when seeking to scale up dietary diversity. The positive relationship between diet quality and body fat has been supported in the literature for certain populations, but not yet in those living in the Pacific (Jayawardena et al., 2013). Rapidly increasing rates of overweight and obesity are critical concerns driving the NCD epidemic across the Pacific, and the current messages of consume less of foods higher in salt, sugar and fat and increase exercise alone are not working. To the authors knowledge, this is the first study to demonstrate a positive relationship between higher levels of food biodiversity in the diet and lower body fat percentage. Adjusting for energy intake did not significantly change these associations (see supplementary information). High body fat is a known risk factor for heart disease, hypertension, stroke, diabetes mellitus, and various forms of cancer (Nishida et al., 2010). Our findings suggest a potential linkage between the consumption a wider variety of traditional, agrobiodiverse foods and a lower body fat percentage.

The nutrition transition is a complex issue with economic, political, physical activity and dietary drivers. Our study reported dietary changes to start during WW2, a global trend that has been reported elsewhere (Barry M. Popkin, 2015). Nutrition transition categories can be identified through 5 stages, of which Solomon Islands appears to be at stage 4 – characterized by decreasing physical activity and westernization of diets leads to increased NCD prevalence (Popkin & Gordon-Larsen, 2004). Overweight and obesity rates have been increasing across the Solomon Island population, for children, adolescences and adults (UNICEF/WHO, 2019). Diabetes prevalence has also been steadily increasing (UNICEF/WHO, 2019). Dietary risk factors are associated with high rates of burden of disease in the Solomon Islands (Afshin et al., 2019). FGD participants reported qualitatively that diets have been changing, moving away from traditional foods to more modern and western style foods – and simultaneously health status has deteriorated in regard to NCD prevalence. Our dietary intake data, while cross-sectional also presents evidence that modern and increasingly processed foods are an important part of the diet and contribute significantly to overall energy intake and increasing rates of overweight and obesity. Together with the high BMIs and body fat percentage documented, these data confirm other documented trends of increasing NCDs that the nutrition transition is underway in Solomon Islands.

FGD participants shared key historical and climatic narratives perceived to be drivers of a nutrition transition. During these discussions, participants identified 221 species and varieties of agrobiodiverse foods available and explained that many varieties are decreasing due to changing demands and preferences towards imported and ultra-processed foods. Participants expressed their concern for the loss of traditional knowledge and food varieties within their Indigenous food system. These perceived nutrition transitions are well-supported by literature where data show processed foods in the Pacific are accelerating, predominantly in low- and middle-income countries, including Solomon Islands. (Santos et al., 2019; Sievert et al., 2019; Thow et al., 2011). Implications of imported processed foods should be further examined with considerations to convenience, affordability, nutrient contributions, and food security.

4.1 Dietary quality and composition

This is the first recent study to examine quantitative dietary intakes among Indigenous Solomon Islanders solely in a rural remote community, and reflect the findings of other dietary assessments conducted in PSIDS (Haddad et al., 2015; Horsey et al., 2019; Hughes & Lawrence, 2005; Konishi et al., 2011). Recent regional data indicate a re-emergence of the nutritional deficiency beriberi (related to vitamin B_1 deficiencies) in the neighboring Pacific island of Kiribati, which has not been seen in over five decades (Nilles et al., 2018). Our data indicates that over three-fourths of women consumed less vitamin B_1 than the EAR, which could be related to the reported increase in consumption of processed foods, in particular of refined white rice, replacing a diverse range of previously utilised traditional foods rich in B vitamins.

Despite having access to a wide variety of traditional biodiverse foods, consumption of food groups were found to be unbalanced. A recent study in Solomon Islands found slightly higher levels of diet diversity, however different food groups classifications were used, which make comparisons difficult (Horsey et al., 2019). Their study population size was much larger and included a key urban center and trading hub, whereas our study focused on a very remote rural community. Horsey et al. (2019) identified that local food preferences were towards diverse diets, similar to what we found through our FGD discussions, as well as through the KAP study. This suggests that the drivers of food choice are more likely to do with situational contexts such as household food security, incomes, production limitations, and climate change.

Coconuts are a culturally-rich traditional food in Solomon Islands. Coconut plantations were subsidised in the 1970's as a way to promote economic opportunities. These subsidies likely influenced dietary transitions within this study population, which comes with tradeoffs. Coconuts are a year-round, low-maintenance, and climate-resilient source of energy and contributed to over half of participant's saturated fatty acids intakes. Our results indicate that over two-thirds of participants were consuming more saturated fatty acids than the recommended upper limit of <10% of total kJ (FAO/WHO, 2010). A recent meta-analysis of 16 clinical trials concluded that coconut fat should not be viewed as healthy when consumed in large quantities in relation to cardiovascular disease risk. (Neelakantan et al., 2020). Saturated fat-rich diets are more obesogenic than diets with lower saturated fat contents (Hariri et al., 2010). Therefore, diets excessively high in coconuts, coupled with increased consumption of saturated fats and ultra-processed foods, may be compounding variables contributing to the rise of NCDs in Pacific populations.

Imported foods contributed the second highest source of energy (kJ) (34.1%) after homegrown garden foods, including both NOVA 1–3 and NOVA 4 categories (22.8% and 11.3% respectively). NOVA 4 category ultra-processed foods are strongly associated with increased rates of NCDs including obesity, cardiovascular disease and cancers (Monteiro et al., 2019). Most published studies that capture ultra-processed foods in the diet come from upper-middle and upper income countries and report higher percentages of ultra-processed foods in the diets, from 15 to 48% (Baker & Friel, 2016; Moubarac et al., 2017). Our study showed that intakes of these ultra-processed foods were relatively low in comparison, not unexpected considering the remoteness of the population. Considering our study was conducted in the lean season, these ultra-processed foods contributed to ensuring populations maintained adequate energy. However, the consumption of these foods are on the rise in Solomon Islands and the Pacific (Horsey et al., 2019), and for a population already battling high rates of overweight, obesity and NCDs, it is imperative that consumption of unhealthy ultra-processed foods does not increase to rates found in more developed countries.

However, it's important not to romanticize traditional diets. The reality is that most of the Pacific will be unable to be completely self-sufficient and reliant on local foods alone. Imported and processed foods have many characteristics that are appealing to consumers. They are often packaged and have undergone transformation and processing that extends their shelf life and decreases cost of production at scale, helping to improve access and close the energy gap in Solomon Islands, particularly in times of high food insecurity. Processed foods are also often preferred as they are quicker to prepare and require less fuel to cook than traditional staple crops, and hence are less of a time burden for women (who are mainly responsible for food preparation and collection of firewood). They also are reported to have a preferred taste, often associated with the high levels of salt, sugar and/or fat in them, together with western diet 'aspiration' and the local perception of these foods being modern and 'non-poor'. However, the increased consumption of imported and increasingly ultra-processed foods displace more micronutrient dense foods (such as roots, tubers, and bananas which are also culturally significant) have other trade-offs on other aspects of food and nutrition insecurity related to negatively affecting diet quality and health (Monteiro et al., 2019). The key is finding the balance between convenience, desirability, health and nutrition.

While the calorie gap has closed with the transitioning food system, dietary gaps for micronutrients and protein remain. Baniata is a coastal village, one that has traditionally relied on fishing as a source of protein. However as reported in the FGDS, wild fish catches are declining due to reported decreases in populations and rises in unpredictable weather patterns, challenging traditional sourcing practices. Despite the opening of the local Noro tuna cannery in 1977, and the community reporting that tuna access than became easier and more affordable in processed form, consumption of protein continues to be insufficient in Baniata. The ease in accessing tinned tuna (which is usually second grade tuna and flesh only) also would decrease the more traditionally caught small reef fish which are often eaten together whole and contain more micronutrients than consuming the flesh alone (Bell et al., 2019). The reliance on tinned tuna flesh may also be furthered due to reduced access to wild reef fish populations due to overfishing and climate change (Bell et al., 2015, 2018). Tinned tuna is preserved in oil, and various brands of processed tinned tuna have founds to have higher contents of fat and salt than what would be with consumption of locally caught fresh fish (Snowdon et al., 2013). Foods such as tayio (canned tuna) are locally processed, high in essential micronutrients, low in mercury, and are shelf stable (Bell et al., 2019). Locally produced canned tuna provides a culturally important and protein-rich processed food for Indigenous Solomon Islanders, and should continue to be promoted as a way to support healthy and resilient food systems for the future. There is an opportunity to create and promote similar processed and shelf-stable foods rooted in traditional knowledge, which contain essential nutrients, take less time to prepare, and meet the cultural and taste preferences of Pacific populations. These foods would have the added benefits of contributing to a stronger local economy by providing improved livelihoods for farmers and sellers of these foods.

4.2 Contribution of local agrobiodiversity to diets

Results from our qualitative FDG data indicate that Baniata's Indigenous food system is rich in agrobiodiversity, that has traditionally supported the local food system. However, historical perspectives from both men and women indicate that the Indigenous food system is shifting away from traditional foods towards imported and processed foods related by external influences, convenience, and taste. The influence of loggers and missionaries highlighted in the FGDs is well documented in other contexts within the country and wider Pacific region (Pollock, 2017).

Intentionally cultivated homegrown foods were the primary source of energy (51.7%), and were primarily sourced from coconut products, starchy root vegetables (sweet potato, taro, yam), and bananas. Wild foods contributed some essential nutrients to local diets; however, community elders and women perceived the collection and consumption of wild foods to be declining. This was surprising, given that coastal Pacific Island communities have traditionally relied on wild fish sources as major contributions to their diet. Given that Baniata is set both on the coast, and on the base of mountains, the lack of wild fish, animals and plants was surprising, especially given the remoteness of the community and that Indigenous communities often rely on wild food sources during lean seasons.

With the exception of seafood, animal sourced foods and protein-rich plant foods were minimally consumed, limiting possible sources of dietary protein. SDA religious followers were restricted from eating mollusks, many of which are traditional sources of protein. Eggs were reported to be minimally consumed, similar to other studies in the Pacific. In many contexts, raising chickens is often an effective way to increase consumption of nutritious animal source foods, which can improve diet diversity and over all diet quality. However, chicken husbandry in the Pacific is difficult, due to the humid, tropical conditions. Opportunities for local egg production using traditional rather than hybrid breeds, may offer a solution (Padhi, 2016).

Overall, homegrown foods still dominate the diet, but reported declining food diversity (species and varieties), a heavy reliance on coconut products, and increase in consumption of imported and processed foods are likely contributing to increased rates of overweight and obesity within the region.

4.3 Food system outlooks

Our findings indicate that traditional knowledge is not adequately being transmitted from older to younger generations. We found a significant discrepancy between adults and youth when discussing knowledge transmission. Adults felt youth were uninterested in learning traditional knowledge pertaining to food systems, however most of the youth expressed their interest in traditional food varieties and continuing with the family farm as they aged. Finding a way to harness traditional knowledge in a way that appeals to youth, such as through school nutrition education or marketing campaigns, may be a way to document and continue the transferring of Indigenous knowledge.

The FGDs provided unique insights into climatic and environmental drivers impacting food system sustainability and dietary diversity, such as stronger storms, increases in pests, and fewer fishing catches. Recent literature supports participant claims, as climate change is expected to be a strong contributor to household food insecurity (Wheeler & von Braun, 2013) by challenging traditional food production and fishing practices (McIver et al., 2016). To build resiliency, innovation is required. Examples include empowering fishermen with more efficient fishing techniques (Asch et al., 2018; Bell et al., 2018), and diversifying food production to supply a wider range of nutritious and climate-resilient crops, such as livestock, legumes, nuts, and seeds (Headey et al., 2018).

Declining agricultural productivity and population growth were both raised as major concerns as threats to the health and livelihoods and food security of Indigenous rural Solomon Islanders. Participants reported little nutrient recycling in the form of manure or food compost to home gardens, which is an exit point for nutrients within the local food system (Mohee et al., 2015; Roos et al., 2016). Poor soil health likely stems from decreased fallowing opportunities and a lack of nutrient-rich soil amendments. Similar observations in declining soil health have been made in the Melanesian Highlands of Papua New Guinea (Fujinuma et al., 2018).

4.4 A case for building a more resilient food system

Our results indicate that improving the production and consumption of agrobiodiversity within food systems may have a positive impact on nutrition by improving the micronutrient content of local diets, and potentially encouraging a healthier body weight. This builds upon the growing evidence that agrobiodiversity is essential for a sustainable food future (Zimmerer & Haan, 2017) and improved human nutrition and health, particularly in light of climate change (Zimmerer et al., 2019). In particular, leveraging a diverse range of neglected and underutilised species which are culturally significant, climate-resilient, and contain high levels of nutrients currently missing in local diets could prove particularly effective in improving diet quality and build residency towards climate change (Raneri et al., 2019).

Supporting innovations that identify novel and appealing approaches to promoting nutritious traditional, neglected and underutilied foods with improved cooking technologies may help improve consumption rates (Dweba & Mearns, 2011), particularly since focus group participants cited enjoyment in the taste of these culturally significant foods. For example, promoting local alternatives to white rice such as golden kumara (beta-carotene rich) provide starchy dietary alternatives, which are less likely to contribute to NCD risk (McLennan & Ulijaszek, 2015). Loss of wild fish has been reported by villagers, but canned tuna can serve as a traditional and non-perishable strategy for improving protein and nutrient intakes. Legumes were found to be severely underutilised and are of particular interest due to their high protein and fibre content, as well as their unique ability to fix nitrogen in the soil and act as a growth-promoting fertilizer (Masset et al., 2014). With the exception of dried ngali nuts, food preservation techniques were underutilised, posing a food security threat in times of poor harvests or during climatic events. Strengthening the capacity of smallholder women farmers to store, preserve, and package local, nutrient-dense foods is likely to help households achieve better food security year-round (Dweba & Mearns, 2011) and potentially reduce dependence on processed and refined imported staple foods.

Trade-offs associated with imported foods should be critically examined from nutritional, environmental, economic, and socio-cultural perspectives. Imported and processed foods can play a role in providing affordable and convenient options for families. Previous studies have documented the links between nutrition knowledge and nutritional literacy with better food choices, healthier diets, and healthy body compositions (Michou et al., 2018; Taylor et al., 2019). Promoting nutrition education, particularly if harnessing traditional knowledge, can help build adaptive capacity towards climate change (Granderson, 2017) and improve the nutrient density of food supplies. It is recommended that nutrition education interventions aim at increasing knowledge of local food benefits, as well as highlighting the risks associated with the overconsumption of ultra-processed foods.

Importantly, Indigenous food systems and associated knowledge provides many answers to concerns of modern-day industrial food systems. Indigenous foods systems have traditionally provided food and nutrition while maintaining natural resources, the environment, and biodiversity. Scaling up Indigenous knowledge can help inform the global debate on improving sustainability of global food systems (Hunter et al., 2016).

4.5 Limitations

Our study was limited to one village's local food system within the Solomon Islands. Data collection occurred during the lean season, limiting our ability to assess the seasonal dietary fluctuations throughout the year. Our dietary assessments were only conducted with the primary cook from each household and do not represent the intakes of the entire household. However, women of reproductive age are often the most nutritionally vulnerable within a household. Additionally, the nutrient composition data of 53 local food varieties were not available and were therefore substituted with the closest documented variety available. Thus, nutrient variations (positive or negative) were not adequately represented in the diet analysis. Hundreds of PSIDS food varieties are missing nutrient composition databases, leaving their unique nutrient contributions to the diet unknown. Updating the Pacific Island

Nutrient Composition Tables Version 2 (Dignan et al., 2004), would improve the quality of analysis and agri-food based interventions. These data can also guide policymakers, researchers, and farmers towards cultivate varieties rich in missing essential nutrients as a food-based approach to mitigating malnutrition (Nesbitt et al., 2010), as well an provide opportunities to update nutrition education materials used in this region to provide specific nutritional information regarding the local agrobiodiversity available.

Scientists have documented the dietary changes occurring in the Pacific and anticipated risks nearly 40 years ago (Fitzroy, 1981). However due to lack of historical data and repeated dietary intakes, we are unable to say empirically what the impact of the transforming food system has had on the diets. Our qualitative data provide some insights into the community's perception, opinions and relayed experiences regarding the shift away from traditional agrobiodiverse foods to more modern, imported and processed foods. Villagers shared their concerns with the noticeable rise in T2DM, high blood pressure, and heart disease within their communities, which were previously rare. Further research carried out over longer periods of time at 1- or 2-year intervals over a minimum period of 5 years will allow an exploration on how diets and health outcomes change.

More studies are needed linking agrobiodiversity, nutrition and food systems, especially those that represent additional ecoregions in Solomon Islands. Currently, there is little nationally or regionally representative data that examines Indigenous peoples' local food systems, utilization of agrobiodiversity, diet quality, and food security. The Pacific is extremely data poor, especially regarding food and nutrition security data. More data will provide the necessary groundwork to improve policies, programmes, and educational interventions aimed at achieving zero hunger through the promotion of sustainable food systems.

5 Conclusion

Indigenous Solomon Islanders living in Baniata have access to an abundance of healthy agrobiodiverse foods, yet are experiencing a nutrition transition towards a more homogenized western-style dietary pattern. Our findings show an inverse relationship between the number of unique species consumed and body fat percentage. Leveraging agrobiodiversity offers opportunities to improve health outcomes and enhance diets with missing essential nutrients. Encouraging domestic production and consumption of agrobiodiversity also supports local economies and builds foods sovereignty, which is of increasing importance under the threat of global food system disruptions related to climate change.

However, significant tradeoffs exist, as imported and modern foods are often less expensive, more accessible, and quicker to prepare. There is a need for a coordinated nutrition strategy which incorporates the multiple dimensions of sustainable food systems, including nutritional adequacy, sociocultural considerations, cost and economic opportunities, and environmental protection. Through nutrition education, policies, and technological innovations, agrobiodiversity can help support food system resiliency while providing economic opportunities that encourage healthy, balanced, and culturally-significant dietary patterns.

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Author contributions CV, JR, and BB conceptualized the study. CV and JR ran data analysis. CV and JR interpreted data. CV and JR prepared the draft manuscript. All authors were responsible for contributing to and reviewing the manuscript. CV and JR contributed equally to this article.

Declarations

Conflict of interest The authors declared that they have no conflict of interest.

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Shane started his career as a lecturer at the School of Natural Resources, Solomon Islands College of Higher Education (now Solomon Islands National University), teaching soils and environmental sciences to tropical agriculture and forestry students. His interests include nutrition sensitive agriculture, agrobiodiversity and sustainable production systems such as agroforestry and organic farming systems and how they influence soil health and adapt to climate change. Shane holds a Masters in soil chemistry and biology from Lincoln University, New Zealand, and a PhD on the biogeochemistry of soil carbon and nutrient cycling in forest plantations from Griffith University, Australia. He is currently managing Zai Na Tina Centre for Organic Systems, which operates an organic farm and provides practical training and research on organics at the outskirts of Honiara, Solomon Islands. He also operates SPE Analytical & Scientific, a private laboratory in Honiara, and co-owns SolAgro, which value adds and trades the ngali nut, an indigenous nut in Solomon Islands. Shane lives with his wife, Mishella, and two sons, Talena and Irava, at Zai Na Tina Organic Farm where they grow their own organic vegetables and enjoy the farm view from their balcony.

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Chapter 5: Assessing food system and nutrition transitions among three geographically distinct Indigenous food systems in Solomon Islands (Melanesia) [Published PDF]

Chapter Title: Assessing food system and nutrition transitions among three geographically distinct Indigenous food systems in Solomon Islands (Melanesia)

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Purpose for inclusion: The aim of this study was to assess nutrition transitions through the comparison of quantitative anthropometric measurements, diet quality measurements, and food sourcing patterns between three geographically unique rural and urban Indigenous Solomon Island populations.

Keywords: Indigenous peoples; Food Systems; Sustainable Diets; Wild foods; Food security; Nutrition

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Article

Assessing Diet Quality of Indigenous Food Systems in Three Geographically Distinct Solomon Islands Sites (Melanesia, Pacific Islands)

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Abstract: Indigenous Solomon Islanders, like many living in Pacific Small Island Developing States (PSIDS), are currently experiencing the global syndemic—the combined threat of obesity, undernutrition, and climate change. This mixed-method study aimed to assess nutrition transitions and diet quality by comparing three geographically unique rural and urban indigenous Solomon Islands populations. Participants in rural areas sourced more energy from wild and cultivated foods; consumed a wider diversity of foods; were more likely to meet WHO recommendations of >400g of non-starchy fruits and vegetables daily; were more physically active; and had significantly lower body fat, waist circumference, and body mass index (BMI) when compared to urban populations. Urban populations were found to have a reduced ability to self-cultivate agri-food products or collect wild foods, and therefore consumed more ultra-processed foods (classified as NOVA 4) and takeout foods, and overall had less diverse diets compared to rural populations. Clear opportunities to leverage traditional knowledge and improve the cultivation and consumption of underutilized species can assist in building more sustainable and resilient food systems while ensuring that indigenous knowledge and cultural preferences are respected.

Keywords: indigenous peoples; food systems; sustainable diets; wild foods; food security; nutrition; SDG 2; Pacific Islands; biodiversity

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1. Introduction

Indigenous Solomon Islanders, like many living in Pacific Small Island Developing States (PSIDS), are currently experiencing the global syndemic, which is the combined threat of obesity, undernutrition, and climate change [1]. Climate change is predicted to challenge accumulated traditional food knowledge through changing landscapes and weather patterns and rising sea levels, with the highest sea rises predicted to occur near the equator [2]. The Solomon Islands (Melanesia) are considered to be a biodiversity hotspot, containing vast genetic diversity and traditional knowledge, which are valuable assets towards ensuring resilient and sustainable food systems in the future [3–5]. However country-level import data suggest that ultra-processed foods such as carbonated soft drinks, baked foods, processed meats, noodles, and sweet biscuits make up the majority of imports in transitioning PSIDS [6]. Additionally, mounting evidence suggests that sharp rises in tropical log exports are degrading local fisheries [7], being linked to decreased ecological resilience and a rise in wealth inequality among Solomon Islanders [8]. Therefore, this study aimed to assess diet quality and food system transitions across three geographically unique Solomon Islands populations.

According to the Committee on World Food Security, food security and nutrition policy are best approached within a sustainable food system framework underpinned by the right to food [9]. A sustainable food system has been defined as "a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised" [10]. The majority of Solomon Islanders live in rural communities and have traditionally relied on subsistence agriculture and fish as their primary source of nutrition [11]. However, knowledge of recent nutrition transitions and associated nutrient contributions of indigenous food systems is limited, particularly when comparing rural populations with rapidly urbanizing populations.

One recent dietary diversity study conducted in the peri-urban population of Malaita [12] found that diet diversity is higher in rural areas compared with peri-urban populations, but it is unknown as to how these findings relate to the urban capital of Honiara, where most urban Solomon Islanders reside. Another recent study found poor dietary diversity among women and young children in rural Solomon Island populations (Western Province and Malaita), with diets dominated by grains, white roots, tubers, and plantains [13]. To understand the relationship between traditional knowledge and barriers to healthy diets, it is critically important to assess diet quality; diversity; sourcing patterns; and the knowledge, attitudes, and practices of those living in geographically unique areas in Solomon Islands [12].

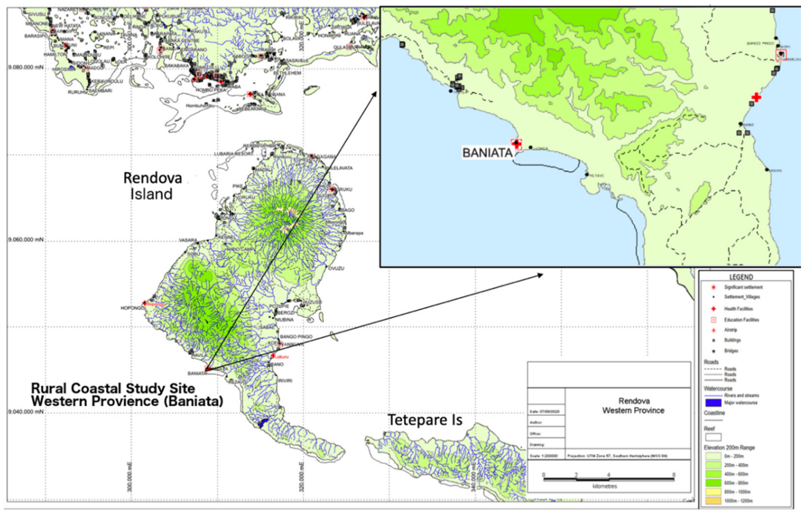
This study aimed to assess nutrition transitions by comparing quantitative anthropometric measurements, diet quality measurements, and food sourcing patterns among three geographically unique rural and urban indigenous Solomon Island populations. Additionally, qualitative key informant interviews were used to contextualize the quantitative data by identifying emerging concerns towards healthy and sustainable foods systems. Quantitative data were collected through the administration of a comprehensive nutrition survey and participatory quantitative interviews with village elders and other key informants.

2. Methods

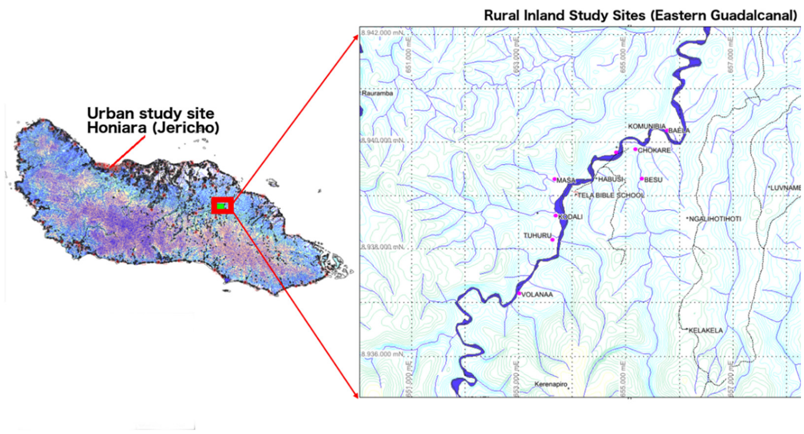
2.1. Study Sites

This research took place in 3 geographically distinct sites across the Solomon Islands, including representation from both rural and urban populations. Snowball sampling was used at each of the 3 sites to ensure randomized sampling. The 2 rural study sites are distinguished by their access to the ocean. The first study site and subsequent 2 study sites were assessed 1 year apart during the same season. The first study site was Baniata village (visited August 2018), a rural coastal village comprised of ≈80 households (≈645 people) and surrounded by native bush and mountains (Figure 1a). Baniata is located on Rendova Island, Western Province, and is accessible only by boat from the neighboring region of Munda. The second study site (visited in 2019) comprised a collection of 8 smaller rural inland villages in Eastern Central Guadalcanal (Figure 1b; Besu, Chokare, Komunibia, Sili, Kukudu, Masa, Kodali, and Tughuru). Accessing these inland villages required a 3-hour drive on dirt roads, followed by a 2-hour hike through native bush. Travelling between villages required a local guide who led our team through the jungle and across rivers to reach individual households. Each village contained 5–10 households, with a total of ≈430 individuals and 50 households across all 8 villages. These rural inland villages were geographically and culturally similar enough to group them into one population. Rural coastal and inland sites had no cellular service, internet, or electricity (with the exception of a few small solar panels). The final study site was an urban community (visited in

September 2019) located in the neighboring villages of Jericho 1 and Jericho 2 with ≈5000 people (Figure 1b). These urban populations serve as proxies for the larger urban population living in Honiara, the largest city and capital of Solomon Islands, with a total population of ≈84,520. Over 80% of Solomon Islanders live outside of Honiara in rural areas.



(**a**)



(**b**)

Figure 1. (**a**) Rural coastal study site, Baniata Village, Western Province. (**b**) Urban study site (Honiara, Jericho 1 and 2), and rural inland study sites (Eastern Guadalcanal). (**a**,**b**) are provided by Carlos Maelaua, a consulting geologist in the Solomon Islands.

2.2. Study Design

We used an observational mixed-method cross-sectional study design. Quantitative surveys were administered to the woman in each participating household who was primarily responsible for household food preparation and agri-food cultivation. Dietary intakes were assessed using the repeat 24 h multiple-pass recall (MPR) method; questionnaires were used to assess knowledge, attitudes and practices (KAP), and food insecurity; and anthropometric measurements were undertaken. Qualitative key informant interviews were held in each village with village elders, and sometimes additional community members, in order to build understanding around current food systems and forecasted food system changes.

The Solomon Islands is home to over 75 distinct languages. Research tools were translated and conducted in the most commonly used language, called pidgin, in order to accommodate language diversity. All survey materials and qualitative key informant questions were pretested in consultation with the nutrition and dietetics professionals from Solomon Island National University for cultural appropriateness, comprehension, and respect for indigenous perspectives and values. Prior to data collection at each study site, dietitian enumerators consulted with village chiefs to ensure sensitive topics were respected and activities that may be considered taboo were avoided.

The first phase of research took place in August 2018 in the rural coastal village of Baniata. The second phase, which included the inland rural sites in Eastern Central Guadalcanal and the urban site in Honiara, took place in September 2019. The second phase study design was modified slightly on the basis of adaptations and feedback from the first phase.

Eight local dietitians/nutritionists from the Solomon Islands National University led the quantitative nutrition survey assessments and qualitative focus group discussions at each study site, and also attended a multiday training to ensure comprehension of the research methodologies. Ethical approval was obtained from the Massey University Human Ethics Committee (#4000020954), as was research clearance from the Solomon Islands Ministry of Education and Human Resources and Development (MEHRD #0668216) and the Solomon Islands National Health and Research Committee prior to commencing this study. Village chiefs were notified, and they granted consent before study commencement.

2.3. Quantitative Nutrition Surveys

Households within each population were randomly selected using a snowball sampling technique. Nutritionists collected quantitative data from women (aged 15–49) who were primarily responsible for cultivating and preparing household foods (n = 94). Women were excluded if they were pregnant or lactating, due to increased energy and nutrient requirements [14]. Nutritionists walked to each selected household and conducted anthropometric measurements, 24 h multiple-pass food recalls (MPRs), and a nutrition survey in each participant's kitchen (when appropriate).

2.4. Anthropometry

Anthropometric measurements included height, weight, and body fat percentage for participants in all of the villages across the 3 study sites. Participants who lived in inland and urban populations were also measured for waist (within 0.1 cm) and calf circumference (within 0.1 cm). Height (within 0.1 cm) was assessed using a tape measure, and each nutritionist was trained accordingly with best practices, including the removal of excess clothing and having the individual stand on a flat surface without shoes [15]. Weight (0.1 kg) was measured using a portable digital weight scale (GreaterGoods Digital Body Fat Scale, Model 0391). Body fat percentages (0.1%) were assessed using a comprehensive bioelectric impedance body composition analyzer (InBody S10). Body mass index (BMI) was calculated from the participants' height and weight (BMI = kg/m^2).

2.5. 24 Hour Multiple Pass Recalls

Quantitative 24 h multiple-pass recalls (24 h MPR) were conducted across 2 nonconsecutive days to represent realistic dietary intakes of participating women [16]. Dietary recalls were adapted to capture both species- and variety-level biodiversity of each consumed food. In addition to types and quantities of foods consumed, cooking methods and brands were also recorded. The sourcing of each ingredient was also captured, and included self-cultivated foods, wild foods, store-bought foods, market purchases, and takeaway foods. If the participant had leftover food or drinks from the previous day's meal, nutritionists directly measured the amount consumed as determined by the participant (≈35% of meals). Portion sizes were estimated by the participant and weighed using digital kitchen scales (Etekcity model EK6015) or measured using graduated cylinders (500 mL and 1000 mL). If the food or drink were not available for direct measurement, then participants estimated quantities of food or drink using water, modelling clay, or strips of paper in the participant's original dishware. Displacement techniques were utilized to determine portion sizes if clay or paper were used to determine portion size. After, food quantities were determined by converting the quantities or densities of the clay/paper by using food density conversion factor estimates from the FAO International Network of Food Data Systems (INFOODS) Density Database [17]. The interview also probed for ingestion of dietary supplements and alcohol.

Food and ingredient source categories included self-cultivated or produced, wild collected, wet market, convenience store, or takeaway meals. Self-cultivated foods are foods intentionally produced by the household for consumption. Wild-collected foods included foods not intentionally cultivated but collected from forests, rivers, or the ocean. Wet market foods are locally sourced from a produce or meat market. Convenience store foods are those foods purchased within a brick-and-mortar shop or a canteen. Takeaway meals are ready-to-eat foods purchased from a street vendor or restaurant.

Nutritional composition data and food groups were sourced from the Pacific Island Food Composition Database (Version 2) [18], Australia and New Zealand food composition databases, and the FAO/INFOODS databases [17]. Food Works (Xyris Version Version 10.0.1) was used to calculate nutrient losses and retentions from food preparation styles (i.e., boiling, drying, etc.). Food varieties that could not be identified in food composition databases were substituted for closely comparable foods. Usual nutrient intakes were calculated from 2 nonconsecutive day 24 h MPRs using the multiple source method (MSM) [19]. Diet consumption data were categorized into the food groups used in the Minimum Dietary Diversity for Women (MDD-W). The level of food processing was classified using NOVA 1–4 categories, with NOVA 4 capturing exclusively ultra-processed foods [20].

The Minimum Dietary Diversity Score for Women (MDD-W) is a proxy for the probability of micronutrient adequacy for women aged 15–49 [21]. Food groups were extracted from consumption data in 24 h MPRs and served as a binary indicator of dietary diversity. Diets that contain five or more food groups (out of a possible 10) have a higher likelihood of achieving micronutrient adequacy [21]. Dietary species richness (DSR) was used to assess agrobiodiversity, and was calculated by counting the unique number of species consumed during each 24 h MPRs [22].

2.6. FAO's Food Insecurity Experience Scale (FIES)

The Household Food Insecurity Experience Scale (FIES) of the Food and Agriculture Organization of the United Nations [23] is an 8-item binary question scale designed to estimate annual household levels of food insecurity. Scores range from 1 to 8, with an average score from 1 to 3 classified as low annual household food insecurity, 4 to 6 as moderate, and 7 to 8 as severe [24]. The FIES is an indicator for SDG 2 (2.1.2).

2.7. International Physical Activity Questionnaire (IPAQ -SF)

The International Physical Activity Questionnaire Short Form (IPAQ-SF) is a 7-item survey designed to quantify weekly physical activity and related intensities for each participant. The IPAQ-SF was adapted to accommodate common activities throughout the Solomon Islands. Three categories of physical activity were used for comparison: low activity, moderate activity, and high activity. Results were converted into MET minutes (metabolic equivalent of task). IPAQ-SF was calculated and analyzed using the IPAQ scoring protocol outlined by the IPAQ Group [25], classified as low, moderate, or high activity.

IPAQ-SF was added to the surveys for the second phase of the study in rural inland and urban sites but were not included in the rural coastal site.

2.8. Knowledge, Attitudes, and Practices (KAP)

Following FAO guidelines, we asked a series of questions to assess the participants' knowledge, attitudes, and practices (KAP) regarding nutrition, agricultural practices, and food waste [26]. The KAP questions were designed to identify specific barriers to accessing and preparing healthy foods. All KAP questions were pretested with local dietitians to ensure comprehension and cultural sensitivities. Data were analyzed to identify how women's knowledge and attitudes influenced practices related to household food preparation. Post-harvest garden and household food waste was estimated by the primary cook of household, with primary foods and reasons for loss recorded.

2.9. Quantitative Data Analysis

Nutrition surveys including 24 h MPRs, KAP, anthropometric measurements, and descriptive data were analyzed using IBM SPSS (Version 25), Tableau (Version 2020.1), RStudio (1.2.5001), and Xyris FoodWorks (Version 10.0.1).

Percentage of participants consuming less than the estimated average requirement (EAR) was used to estimate the prevalence of inadequate nutrient intakes. EAR is defined as the average daily nutrient intake level that is estimated to meet the requirements of 50% of the healthy individuals in a particular life stage and gender group [27]. The population prevalence of inadequate intakes was computed using the EAR cut point method for each unique study site [28]. The EAR cut point method was computed by calculating the proportion of individuals with usual intakes below the EAR for calcium, vitamin B_{12}, folate, selenium, potassium, vitamin A_{eq}, thiamine, and zinc. The full probability approach was used to determine average probability of inadequacy for iron. This approach is necessary to adjust for absorption limits and iron losses among menstruating women [(Observed Intake × Upper limit) − 0.87(assumed basal loss of iron)] [29].

The World Health Organization and the FAO recommend a minimum of 400 g of non-starchy fruit and vegetables (NSFV) per day to prevent chronic diseases such as heart disease, cancer, diabetes, and obesity, as well as to prevent and alleviate several micronutrient deficiencies, especially in less developed countries [30]. NSFV intakes were extracted from 24 h MPRs and compared to the WHO/FAO recommendation of 400 g/day.

Linear regression models were used to demonstrate the relationship between body fat percentage and the average number of species consumed (DSR), knowledge of healthy diets, and consumption of dark leafy vegetables, with $p \leq 0.05$ regarded as significant.

2.10. Estimation of Misreporting of Dietary Intake Data

Misreporting of dietary intake data was controlled for using Goldberg cutoff points. Cutoff points were calculated by comparing energy intakes (EI) with estimated basal metabolic rate (BMR_{est}) using the Harris–Benedict equation [BMR = (10 × Weight) + (6.25 × Height) − (5 × Age) − 161] [31]. Underreporting was defined as EI: $BMR_{est} < 1.15$, and overreporting as > 1.96 [32].

2.11. Village Comparisons

A one-way ANOVA was used to determine intra-village differences in anthropometric, lifestyle, and diet quality data. Normality checks and Levene's test were conducted and the assumptions met. Post hoc comparisons using the Tukey test were carried out.

2.12. Qualitative Analysis

Key informant interview questions were structured on the basis of previously conducted surveys in the Solomon Islands aimed at characterizing the sustainability of indigenous food systems. Data were summarized to contextualize quantitative findings using the qualitative software NVIVO 12 (Version 12.6).

3. Results

3.1. Food System Comparisons

Comparisons between three geographically distinct indigenous Solomon Island food systems are provided for rural coastal, rural inland, and urban populations in Table 1. Clear distinctions were found between rural and urban populations, including population size, accessibility, proximity to markets, agri-food production, and wild food collection.

Table 1. Characteristics and food system descriptors for three geographically unique indigenous Solomon Island populations.

Descriptor	Rural Coastal	Rural Inland	Urban
Sample size	Households (n = 30)	Households (n = 32)	Households (n = 33)
Village name (s)	Baniata	Multiple villages (Besu, Chokare, Komunibia, Sili, Kukudu, Masa, Kodali, Tughuru)	Jericho 1 and Jericho 2
Location	Coastal village on Rendova Island in the Western Province	Eastern rural inland villages, Guadalcanal	Honiara (capital city), Guadalcanal
Population	≈645 villagers and 80 households	≈430 villagers and 50 households	>84,500 (total population)
Season	Lean season (July/August 2018)	Rainy season (August/September 2019)	Rainy season (August/September 2019)
Food insecurity (FIES)	FIES Composite: 4.1 Moderate food insecurity	FIES Composite: 2.5 Low food insecurity	FIES Composite: 2.2 Low food insecurity
Household monthly income (average)	SBD 1043 (USD 125) [SD SBD 416 (USD 53)]	SBD 965 (USD 115) [SD SBD 569 (USD 68)]	SBD 1115 (USD 133) [SD SBD 719 (USD 86)]
Household size (average)	6.5 people per household (SBD 160 pp/month)	5.1 people per household (SBD 193 pp/month)	6.9 people per household (SBD 161 pp/month)
Accessibility	Village access requires a 90-min commute from the regional capital of Munda on a wooden petrol-powered fishing boat.	Village access requires a 3-h drive on dirt roads and across rivers from the capital city of Honiara, followed by a 2-h trek to reach inland river villages.	Villages are centrally located within the urban capital of Honiara.
Proximity to external markets	The closest wet market was located in Noro, which requires boat access. Baniata had 2 boats, which limits the number of villagers who are able to sell their agri-food products each day.	The closest wet market is in Honiara (above) and takes a considerable amount of time to access.	Neighborhood markets external to Jericho exist, but the Honiara central market is the closest. Walking would take 1.5 h, and a bus would take 30 min (during business hours).
Internal markets or canteens	An internal canteen exists with a limited selection of basics such as noodles, flour, oil, rice, biscuits, candies, and tobacco products.	An internal canteen exists with a limited selection of basics such as noodles, flour, oil, rice, biscuits, candies, and tobacco products.	No internal market exists, but street foods, select produce, and basics are available for sale directly outside of the village.
Agri-food cultivation and production	All women participated in agri-food cultivation and production and market sales.	All women participated in agri-food cultivation and production and market sales.	Women were less involved with agri-food production, cultivation, and sales and had a wider variety of responsibilities, including the formal sector or as a caretaker.
Wild food access	Ocean and bush were accessible to all villagers, and wild foods were collected to supplement diets.	River and bush access were accessible to all villagers, and wild foods were collected to supplement diets.	Ocean and bush access were not accessible to villagers, and wild foods did not play a large role in dietary intakes.
Food loss and waste, and preservation	A total of 26.9% (SD 16.5) of food was self-reported lost or wasted, with primary foods being vegetables, starchy staples, and nuts/seeds; ≈30% of villagers dried or smoked food for preservation.	A total of 29.1% (SD 11.3) of food was self-reported lost or wasted, with primary foods being vegetables, fruits, and starchy staples; ≈ 25% of villagers dried or smoked food for preservation.	A total of 31.1% (SD 11.1) of food was self-reported lost or wasted, with primary foods being vegetables, fruits, and starchy staples. Few in the urban setting practiced food preservation techniques.

3.2. Excluded Data

One participant's dietary data were removed due to underreporting (Goldberg cutoff point of > 1.96).

3.3. Anthropometric and Physical Activity Measures

Rural populations, on average, had significantly lower body fat percentage, BMI, and waist circumference when compared to urban populations (Table 2). Rural villagers exerted 853 more MET minutes per week of physical activity than the urban population, with the majority of rural participants achieving "high activity" levels. However, 90.1% of urban and 93.8% of inland rural participants achieved the physical activity recommendations of 600 weekly MET minutes set by the WHO. BMI was highly correlated with both body fat percentage (p =< 0.0001, r^2 = 0.73), waist circumference (p =< 0.0001, r^2 = 0.77), and calf circumference (p =< 0.0001, r^2 = 0.47).

Table 2. Mean anthropometric, health, and diet quality indicators across rural coastal, rural inland, and urban Solomon Island populations (n = 94).

Indicator	Rural (Coastal)	Rural (Inland)	Urban	Overall (Average)
Anthropometrics and health				
Age	37.1	39.8	37.0	37.9
Body fat percentage (%)	30.1	30.6	35.9 *	32.4
BMI	26.1	26.7	30.2 *	27.7
Waist circumference (cm)*	-	90.9	96.8 *	93.9
Calf circumference (cm)*	-	35.4	37.6 **	36.5
MET minutes (average/week) *	-	4338 *	3503.2	3920.6
% Low activity	-	*6%*	*13%*	*9.5%*
% Moderate activity	-	*41%*	*54%*	*47.5%*
% High activity	-	*53%*	*33%*	*43%*
Diet quality				
Dietary species richness (DSR)	7.1 *	6.7	5.8	6.5
MDD-W (DDS)	4.2 **	3.8	3.7	3.9
% DDS >= 5	26.6% **	13.1%	12.1%	17.2%
% >400 g NSFV	79.2%	77.4%	42.2% **	66.2%
Diet % ultra-processed (NOVA 4)	6.8	11.7	17.9 *	12.13
Takeout (#/week) *	-	0.3	1.3 *	0.8

* p =< 0.001, ** p =< 0.01. Waist circumference, calf circumference, MET minutes, and takeout data not available for rural coastal village.

3.4. Dietary Quality and Diversity

Diets in rural villages (both coastal and inland) largely were predominately sourced from self-cultivated and wild foods, including root vegetables (taro, cassava, and kumara), bananas (cooking and eating), dark green leafy vegetables (kasume fern, slippery cabbage), and coconut products (cream). Both types of rural villages sourced significant protein from canned tuna, but differences existed in terms of access to wild food. Coastal villagers wild-collected protein from the ocean and the bush, whereas inland villagers sourced their protein from the nearby river (ora, grey fish, and wild pig) as well as from the bush.

Diet quality differed significantly among the three study populations (Table 2). Dietary species richness (DSR) was significantly higher in rural populations. The number of species consumed was correlated to the utilization of wild and cultivated foods in both urban and rural populations (r = 0.13, p = 0.003). The DDS mean score for rural coastal populations was significantly higher than for the rural inland population. The average number of participants across three sites achieving >5 DDS was 17.2%, indicating a high percentage of participants are unlikely to achieve nutrient adequacy. The majority (>75%) of participants in rural areas achieved the WHO recommendation of >400 g of non-starchy fruits and vegetables daily, compared to less than half (42.2%) of the urban population who met this recommendation. Ultra-processed foods (NOVA 4) were consumed exponentially according to proximity to the urban center, and the most commonly consumed such foods were white breads, instant noodles, donuts, Milo drink mix, milk tea, and sausages.

3.5. Energy and Nutrient Intakes

Energy, macronutrient, and micronutrient intakes for the study populations are compared in Table 3. The prevalence of inadequate micronutrient intake of each population is indicated in Figure 2. The rural coastal village had the highest prevalence of participants who did not achieve the EAR for micronutrients of concern, followed by the rural inland and urban sites. More than half of the calcium intake for the rural populations came from dark green leafy vegetables, including slippery cabbage, wild fern, and leaves from root crops. Potassium was low for the urban population due to lower intakes of green leafy vegetables and roots, tubers, and bananas. The prevalence of inadequate vitamin A_{eq} and thiamine intakes were lower in the rural inland and urban food systems in part due to the rice fortification policy mandate in November 2018, which was enacted after data collection in the rural coastal food system. However, both rural food systems sourced significant quantities of vitamin A_{eq} from cultivated, purchased, or wild collected dark green leafy vegetables.

Table 3. ANOVA comparisons of usual macro- and micronutrient intakes among three unique populations (n = 94).

Nutrient	Rural Coastal	Rural Inland	Urban	Overall Average
		Macronutrients		
Usual energy intake (kJ)	7648.3	8549.7	9067.7 **	8421.9
Calories (kcal)	1828.0	2043.4	2167.2 **	2012.9
Total fat (g)	62.1	79.7 **	63.7	68.5
Saturated fat (g)	52.5 *	43.8	33.9	43.4
Carbohydrates (g)	224.7 *	308.2	328.6	287.2
Sugars (g)	61.7	57.9	60.7	60.1
Dietary Fiber (g)	22.8	33.2 *	20.6	25.5
Protein (g)	40.7	42.2	56.5 *	46.5
		Micronutrients		
Vitamin A eq (μg)	379.8	908.9 *	599.7	629.5
Vitamin B_1 (mg)	0.67	1.5 *	2.2 *	1.5
Vitamin B_2	0.61	0.81	0.64	0.69
Vitamin C (mg)	84.7	193.4 *	111.7	129.9
Calcium [Ca] (mg)	290.7	483.7 *	320.9	365.1
Sodium [Na] (mg)	1376.8	1506.2	1934.2 *	1605.7
Potassium [K] (mg)	3204.6 *	4386.5 *	2284.9	3292.0
Magnesium [Mg] (mg)	416.8	504.8 *	257.6	393.1
Iron [Fe] (mg)	11.4 *	16.9	16.1	14.8
Zinc [Zn] (mg)	8.17 *	14.6	16.7	13.2

* p =< 0.001, ** p =< 0.01.

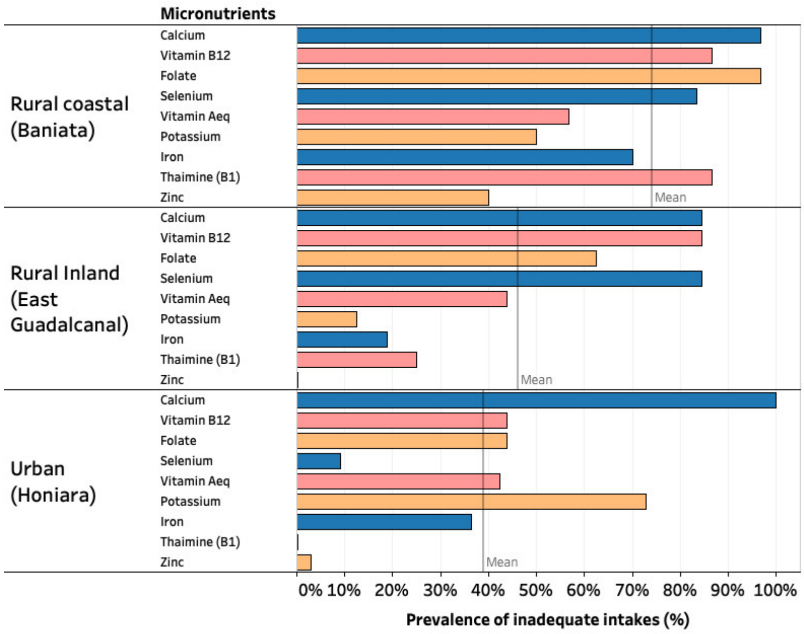


Figure 2. Prevalence of inadequate micronutrient intakes within three geographically distinct indigenous Solomon Islands food systems (*n* = 94).

Nutrients that were low in rural food systems but not in urban ones were vitamin B_{12} and selenium. Urban food systems sourced the majority of their vitamin B_{12} from canned tuna (taiyo), and selenium was sourced from canned tuna (taiyo) as well as from fortified white rice. Low consumption of animal-sourced foods, including fish, dairy, and meats, contributed to low vitamin B_{12} intake in the rural villages. All three study sites, on average, did not exceed sodium recommendations.

Macronutrients in all three food systems supplied higher than the recommended intakes of saturated fats and total sugars (Figure 3). Saturated fats were primarily sourced from coconut and coconut products. Sugars were primarily included in the diet in the form of sugar-sweetened beverages. Only the rural inland food system was able to meet fiber recommendations. On average, rural populations did not achieve protein recommendations, whereas the urban population did (Figure 3). Overall, mean energy consumption for each population was met; however, deficiencies in essential nutrients remain, including protein, vitamin B_{12}, and calcium.

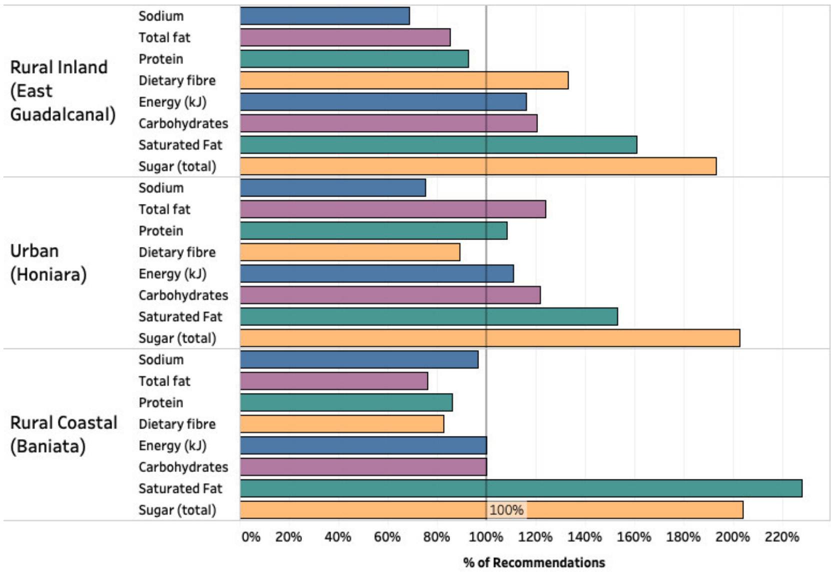


Figure 3. Macronutrient intakes compared with dietary recommendations in three geographically distinct food systems ($n = 94$). Energy requirements were compared to total energy expenditure (TEE) from basal metabolic rate (BMR) + physical activity level (PAL). Total fat recommendations <30% total kcal and saturated fat recommendations <10% of total kcal [33]. Sugar limits are sourced from WHO guidelines (2015) and salt limits from American Heart Association guidelines (2020).

Using a linear trend model, we found a significant decline in dietary energy (kJ) sourced from cultivated and wild collected foods among younger participants when compared with older participants in both rural and urban settings ($p =< 0.001$). There was a significant increase of store-bought foods in the urban population compared to the rural populations (Figure 4). Energy sources from wild foods were negligible in the urban populations when compared to the rural populations.

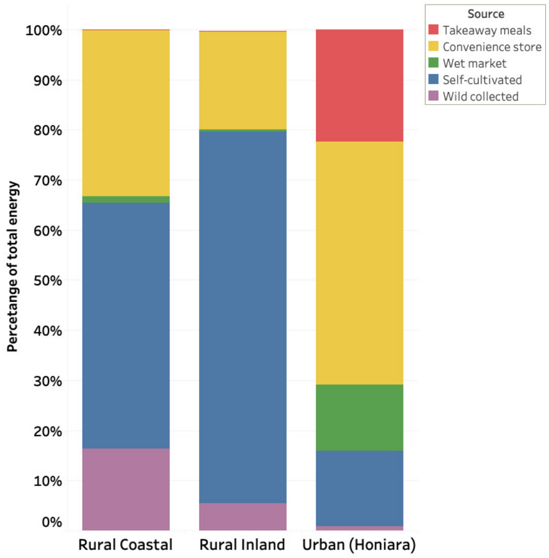


Figure 4. Energy food source patterns between three geographically unique indigenous Solomon Island populations (n = 94).

Table 4 compares the top five food sources of energy, iron, calcium, vitamin A_{eq}, and zinc in the rural inland and rural urban populations. Food energy from rural inland diets was sourced primarily from coconuts, root crops, and fortified white rice. In contrast, diets in the urban population were characterized by fortified white rice, fortified refined grain products, coconuts, cassava, and added sugars. Fortified white rice was the top contributor of zinc and iron for both rural inland and urban participants.

Table 4. Top five species contributing to energy, iron, calcium, vitamin A_{eq}, and zinc in diets.

#	Rural Inland	% Total	Urban	% Total
		Energy (kJ)		
1	Coconuts	24.07%	White rice	28.13%
2	Bananas	21.26%	Refined wheat products	18.36%
3	White rice	14.87%	Coconuts	12.64%
4	Taro (roots, leaves)	7.03%	Cassava	10.01%
5	Sweet potatoes	4.73%	Sugars (added)	6.54%
		Iron		
1	White rice	21.11%	White rice	44.37%
2	Taro (roots, leaves)	13.27%	Slippery cabbage (bele)	9.17%
3	Fern (wild)	11.20%	Refined wheat products	14.86%
4	Coconut	14.11%	Cassava (roots, leaves)	6.58%
5	Slippery cabbage (bele)	7.41%	Tuna (canned, fresh)	1.77%
	% of women below EAR	18.8%	*% of women below EAR*	36.4%
		Calcium		
1	Taro	38.68%	Refined wheat products	27.57%
2	Slippery cabbage (bele)	17.00%	Slippery cabbage (bele)	27.36%
3	Fern (wild)	2.73%	Cassava (roots, leaves)	9.00%
4	Pumpkin	8.22%	Coconuts	2.76%
5	Sweet potato	4.41%	Tuna (canned, fresh)	1.10%
	% of women below EAR	84.4%	*% of women below EAR*	100.0%
		Vitamin A (eq)		
1	Sweet potato	71.21%	Slippery cabbage (bele)	32.95%
2	Slippery cabbage (bele)	19.93%	Cassava (roots, leaves)	26.20%
3	Fern (wild)	13.88%	Pumpkin (fruit, leaves)	14.03%
4	Taro (roots, leaves)	11.01%	Oil (fortified)	4.58%
5	Pumpkin (fruit, leaves)	7.33%	Taro (roots, leaves)	2.62%
	% of women below EAR	43.8%	*% of women below EAR*	42.4%
		Zinc		
1	White rice	29.94%	White rice	53.45%
2	Taro (roots, leaves)	16.85%	Cassava (roots, leaves)	21.79%
3	Cassava (roots, leaves)	11.15%	Refined wheat products	4.32%
4	Fern (wild)	9.33%	Coconuts	3.17%
5	Coconuts	8.85%	Slippery cabbage (bele)	1.75%
	% of women below EAR	0.0%	*% of women below EAR*	3.0%

Through a linear regression analysis, we found that participants who had a higher knowledge of healthy diet patterns, consumed a wider diversity of species (DSR), and consumed more dark green leafy vegetables (by weight) were significantly more likely to have healthier body fat percentages (p =< 0.001, R^2 = 0.261). No significance was found between participants' body fat percentage and total energy consumption from NOVA 4 ultra-processed foods.

Results from the KAP survey (Figure 5) indicated that most women felt it was important to provide fruits (93.6%) and vegetables (95.7%) for their families (n = 94). Rural population attitudes towards the affordability of access to fruits and vegetables were slightly but significantly more favorable than among urban participants. Nearly half (47.5%) of rural women felt meat was an important part of the diet, whereas only 21.7% of the urban population shared this view. There was a significant increase in urban women who felt it was difficult to get their children to eat fruits and vegetables when compared to the rural population (27.7% and 50.1%, respectively).

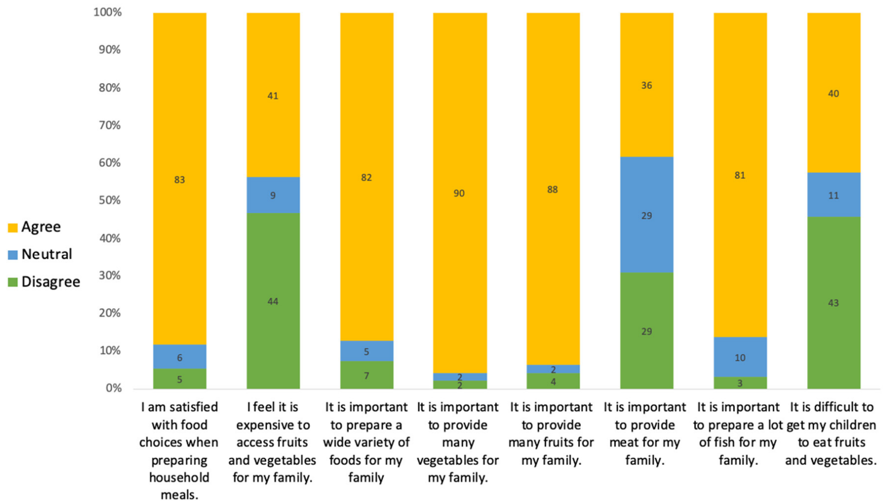


Figure 5. Knowledge, attitudes, and practice survey results among rural and urban women (n = 94).

3.6. Qualitative Key Informant Interviews

Village elders are the leaders of their respective communities in the Solomon Islands and are the primary host of the villager's traditional knowledge. Results for qualitative key informant interviews from each village elder's food system were summarized and categorized into three primary areas:

1. Traditional knowledge loss: Elders from all three study sites expressed their interest in sharing indigenous and traditional knowledge with the younger generations, but children were often unwilling to listen unless required. One elder summarized this concern by stating, "All traditional knowledge is passed, but kids do not want to do it."
2. Traditional food declines: Seasonal fluctuations of market produce prices within the urban population impact the ability to purchase certain locally grown foods. One elder added, "However, rice has filled the void of these fluctuations and cost barriers," and another added that "adults get tired of rice all the time, but kids only want rice. Now, the kids' preferences are influencing parents' preferences, too." Rural village elders expressed that local breeds and varieties are decreasing overall. Rural inland populations now cultivate their agri-foods 1 hour away (walking) from their village to be closer to the road for easier market access, but this now limits the quantity of traditional foods that are carried back to the village. Additionally, rural inland villagers and urban villagers on the island of Guadalcanal are facing the recent threat of invasive giant African land snails (*Achatina fulica*), which decimate crops by the thousands. One elder stated, "We used to plant slippery cabbage near our house, but now the snails eat them all."
3. Climate change and weather patterns: Urban and rural elders expressed their concerns about climate change and associated weather pattern changes. Respondents said that dry seasons have decreased and that increases in rain throughout the year have caused many crops not to grow as well. One village elder shared the challenges to the local food system by stating, "We used to listen to the weather, but now we cannot."
4. 4. Discussion

We found substantial differences in anthropometric measures, macronutrient and micronutrient intakes, and MET minutes between rural and urban Solomon Island populations. We also found significant differences in food sourcing patterns between rural and urban populations, with urban populations often replacing wild or self-cultivated agri-foods with purchased and ultra-processed foods. Overall, participants in rural areas sourced more energy from wild and cultivated foods; consumed a wider diversity of foods; had a higher probability of meeting WHO recommendations of >400 g of NSFV daily; were more active physically; and had significantly lower body fat percentages, waist circumference, and BMI when compared to urban populations. Overall, an average of 17% of the study population achieved dietary diversity scores (MDD-W) ≥5, slightly higher than recent diet diversity findings from populations living in the semi-urban areas of Malaita [13].

Since our data collection in the rural coastal village of Baniata in 2018, rice, wheat flour, and vegetable oil have been fortified with zinc, iron, vitamin A_{eq}, and thiamine (2019). Since a larger proportion of participants achieved intakes above the EAR for these micronutrients in both rural inland and urban populations, fortification may be a significant influencing factor of nutrient adequacy for these select nutrients. Fortified white rice was the main source of zinc for rural inland and urban populations. Salt is fortified with iodine, and most participants achieved the EAR. Food fortification may solve single micronutrient deficiencies but could ultimately reduce the sustainability of indigenous food system and give rise to diet-related noncommunicable diseases (NCDs), particularly since most fortified foods are imported and tend to be processed.

Urban populations consumed significantly more protein and ultra-processed foods (NOVA 4), were more likely to eat takeout foods, and had less diverse diets compared to rural populations. Less than half of urban participants met their recommended NSFV intakes. Whole, minimally processed foods contain a wide diversity of antioxidants, phytochemicals that protect against heart disease, T2DM, and obesity [34–36], of which urban populations are less likely to eat due to lack of accessibility. If ultra-processed foods (NOVA 4) continue to displace traditional foods, as evidenced by trends across the broader Pacific [6], NCD risks will likely continue to rise, even if levels of essential micronutrients are met through fortified foods. Additionally, modelling of staple crops predict that protein content and micronutrients of rice and wheat will decline significantly as atmospheric carbon dioxide rises [37]. Populations that rely heavily on single staple foods as their primary source of nutrition will experience proportional adverse impacts of these nutrient losses, aggravating existing cases of malnutrition and encouraging new ones [38].

Seafood is a critical and culturally important food for achieving food and nutrition security in the Solomon Islands. Urban participants sourced vitamin B_{12} primarily from canned tuna (taiyo), as well as selenium from canned tuna and fortified white rice. Low consumption of animal-sourced foods, including fish, dairy, and meats, contribute to low vitamin B_{12} and protein intake in rural populations. Low vitamin B_{12} intake can result in irreversible neurological damage if B_{12} is underconsumed for long periods [39]. Some options to ensure adequate vitamin B_{12} intake within vulnerable populations include the promotion of more animal-sourced foods, supplementation, and fortification. Tuna catches are predicted to rise in PSIDS over the next 50 to 80 years due to changing ocean currents, potentially serving as a regionally abundant source of protein and other essential nutrients for current and future food systems [40]. In the short term, canned fish can help fill the gap between sustainable coastal fish production and recommended fish intakes [40].

Dietary diversity was found to be lower in the rural inland site than in the rural coastal site, which is likely related to the inland villagers' current struggle with the invasive giant African land snail (*Achatina fulica*). This destructive snail appeared in Guadalcanal rivers nearly three years ago, and has caused widespread damage to numerous crops of value, including kumara, slippery cabbage, and bananas. Villagers shared that their tolerance is low for this invasive species and that it is causing great stress. More data are needed examining the impacts from African snails in relation to diet quality, particularly for maternal and child health. While snails are not currently consumed, they are edible (when properly prepared), and provide essential trace minerals needed for optimal growth and development, including iron, magnesium, calcium, phosphorus, and potassium [41]. If culturally appropriate, education around the preparation and consumption of giant African snails may help to mitigate malnutrition in vulnerable populations such as children and pregnant women. An additional contribution to reduced dietary diversity within the rural inland site is that home gardens have recently moved further away from homes (a 1.5 h walk) and closer to the main road where transportation is available to reach produce markets. This increased distance from gardens to homes may impact household diet diversity as the food's weight and space are of concern when hiking back from the gardens.

Calcium is a nutrient of concern for all populations. Calcium-rich foods are primarily sourced from starchy staples and dark green vegetables, with the exception of the urban population, who source most calcium from refined grain products. Betel nuts (*Areca catechu*) are a commonly chewed stimulant drug, used regularly by 45% of participants in urban and rural sites. Consumed alongside the nut is dried, crushed coral (calcium carbonate; $CaCO_3$), which may provide >100% of the user's EAR for calcium (3 g = 1000 mg, or >100% EAR). However, betel nuts are a highly addictive and accessible cancer-causing drug [42].

Ultra-processed foods (NOVA 4) have the worst nutrient profiles yet are becoming the most prevalent foods within global food systems, including in the neighboring countries of Australia and New Zealand [43,44]. NOVA 4 were consumed in all three study sites, with the highest consumption within the urban population. Interestingly, the consumption of ultra-processed foods had no correlation with body fat percentage or BMI. However, numerous global studies have found significant inverse associations between consumption of NOVA 4 foods and fiber, potassium, and micronutrients [45]. The most common ultra-processed foods were doughnuts, bread, instant noodles, Milo drink mix, and sausages. Takeaway meals consisting of fried meats or fish, sausages, and rice were more common in the urban populations. Fewer ultra-processed foods have made their way to rural areas, likely due to the journey required to access the villages.

Our findings suggest that higher body fat percentages were highly correlated with higher BMIs and waist circumferences, and therefore body fat percentage was used as a primary health indicator due to its relation to NCDs and chronic disease risk [46–48]. We found that lower body fat percentages were significantly correlated with a greater intake of unique numbers of species, higher knowledge of healthy diets, and increased intakes of dark leafy green vegetables. These results align with observations from Tsuchiya et al. (2017), where lower frequencies of green leafy vegetable consumption and dietary diversity were associated with increased rates of obesity in the urban setting of Honiara [49].

Food insecurity was classified as moderate in the rural coastal community and classified as low in the rural inland and urban communities. Food security is often provided through "insurance crops", such as swamp taro; kasume (wild fern); and, more recently, imported white rice. Nutrition security, however, is nonetheless a cause for concern, as adequate supplies of essential nutrients are not available year-round per current food system availability [50].

Recent findings from Solomon Island populations indicate that overall nutrition knowledge is weak, which can impede informed choices regarding food consumption [13]. Additionally, urban women in our study perceived getting children to eat fruits and vegetables to be twice as challenging as women in the rural settings. This difference could be related to changes in urban food environments, including advertisements, lack of cultivation opportunities, or perceptions that traditional foods are old-fashioned. Nearly half of rural women felt meat was an important part of the diet, whereas only 21.7% of urban participants shared this view. This could be related to the sourcing of meat, in that in rural settings meat is typically sourced from the bush, whereas in urban settings meat is typically consumed via less healthy sources such as processed sausages or fried chicken.

Both urban and rural village elders expressed their concerns regarding the loss of traditional knowledge, as well as concerns for an increasing reliance on less healthful, imported foods. While imported foods can fit into a healthful diet, it is important to recognize the potential sustainability trade-offs associated with displacing traditional foods rich in nutrients with energy-dense imported and ultra-proceeded foods. Other Melanesian PSIDS, such as Fiji, have much higher rates of childhood and adult obesity compared to the Solomon Islands, likely associated with a lengthier exposure to energy-dense and nutrient-poor foods [51].

4.1. Implications and Further Research

Indigenous knowledge can help build local food system resilience, strengthen food and nutrition security, and help to inform the global debate on improving the sustainability of global food systems [52]. Studies have identified that agroecological approaches informed by participatory research and indigenous knowledge can help empower communities and increase food sovereignty [53]. Neglected and underutilized agri-food species also have the potential to generate income for farmers, meet demand in local markets, and contribute to meeting UN sustainability goals [1].

A recent technical report identified community food production initiatives in PSIDS as part of the solution for addressing food and nutrition insecurity by increasing dietary diversity and incomes while reducing household food expenditure [54]. Strategies aiming to improve the nutrition and health outcomes of indigenous food systems should begin with the inclusion of traditional knowledge, values, and priorities. Additionally, convenience, affordability, and income-generating opportunities are important considerations when aiming to improve food systems' contributions to human and planetary health. Future research should examine how the multiple dimensions of sustainable diets, including nutritional, environmental, economic, and sociocultural, can be achieved. Utilizing and promoting the food-based dietary guidelines for the Solomon Islands can help guide policies and educational efforts towards culturally significant, nutritious, and balanced diets.

Lastly, a deeper examination of ingredients used within ultra-processed foods is warranted, particularly those containing trans fatty acids under the ingredient name "partially hydrogenated oil". Trans fatty acids have historically been poorly displayed on nutrition facts labels in Solomon Islands, findings that are confirmed by a large-scale study examining completeness of nutrition information facts with 6000+ food and drinks in Fiji [55]. Trans fatty acids, even in small quantities, are extremely deleterious to cardiovascular health and overall NCD risk [56].

4.2. Limitations

The 24 h multiple pass dietary recall methodology has not been adapted for a Solomon Islands population, and therefore population-specific adjustments are not known. However, we countered this limitation by using the Goldberg cutoff methodology to reduce the likelihood of under- and over-reporting. Another limitation is that BMI cut points have not been established for Melanesian populations, and therefore we used additional metrics such as body fat percentage and waist circumference. There was a one-year span between the first round of data collection (2018) and the second (2019). Researchers controlled for this by conducting the study during the same time of year, but also acknowledge this as a limitation. Sample populations were selected to represent three geographically distinct environments in which the majority of Solomon Islanders live. However, Solomon Islands is an archipelago of 900+ islands with over 75 distinct languages, and therefore each community has unique challenges and opportunities when aiming to obtain food and nutrition security. Additional food systems research is required to further understand dietary diversity, quality, and transitions in more remote island locations. Food composition data are severely lacking for a wide diversity of available varieties of foods across the Pacific. Updating the Pacific food composition tables can help provide food-based and culturally significant solutions to mitigating malnutrition.

5. Conclusions

Clear anthropometric, diet-quality, and sourcing differences were found between rural and urban participants. We found urban populations to be at a significantly increased risk for obesity and NCDs. Estimated requirements of zinc, iron, folate, and vitamin A_{eq} were met by the majority of participants after fortification mandates for rice, flour, and oil were enacted in November 2018. These fortifications should improve malnutrition outcomes for vulnerable populations. However, fortified foods may artificially inflate individuals' confidence in the quality of their diets, since our findings indicate that traditional foods are being displaced by imported and ultra-processed foods. As urbanization increases, declines in knowledge of traditional agri-food are accelerated through shifts towards industrially processed foods and changes in the taste preferences of younger generations.

Villagers expressed strong interest in understanding how they can improve their diets to achieve better nutrition outcomes within their communities. Elders expressed grave forecasts about traditional knowledge losses, changing dietary patterns, and climate change. Certain processed foods, particularly those which are locally produced, can play a critical role in achieving food and nutrition security as well as food sovereignty—a critically important concept given the recent food system disruptions caused by the COVID-19 pandemic. Unless action is taken to preserve and integrate traditional knowledge, associated food and nutrition security benefits will likely continue to rapidly erode. There are clear opportunities to leverage traditional knowledge and improve cultivation and consumption of neglected and underutilized species that can help build more sustainable and resilient food systems while ensuring indigenous knowledge and cultural preferences are preserved.

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Chapter 6: Discussion and Recommendations

The primary aim of this research was to assess the sustainability of food systems of Indigenous peoples living in Pacific Small Island Developing States (PSIDS), with a specific focus on Solomon Islands. Previous research and documentation suggest that diets and food systems in PSIDS were once healthy and sustainable (Damon, 1974), but that over the past few decades, diet transitions, urbanization, and climate change are resulting in less resilient and less sustainable food systems (Campbell, 2015; Hughes & Lawrence, 2005; Kuhnlein et al., 2018).

Findings from this research suggest that Indigenous Melanesians are experiencing new pressures related to urbanization and climate change that challenge traditional ways of life. The nutrition transition in Melanesia has been occurring over the past few decades, albeit at a slower pace than in other countries in the broader Pacific (Global Nutrition Report, 2020). This thesis' data show that urban Solomon Island populations had significantly lower dietary diversity and quality, as well as lower physical activity, than rural populations (n=95 women representing their respective households). Urban populations also had significantly higher body fat composition and energy intakes (kJ) and consumed more ultra-processed foods when compared to rural populations.

Furthermore, discussions with rural and urban village elders and community members suggested that Solomon Island food systems are declining in diversity (including seafood) and that associated traditional knowledge is not being adequately captured or passed down to younger generations. Additionally, urban participants were significantly less likely to meet the WHO's daily recommendation of 400 grams of non-starchy fruits and vegetables when compared to rural participants (77% and 44%, respectively). Mean findings from three study populations indicated overconsumption of saturated fat (primarily from coconuts), added sugars and, on average, lower-than-recommended protein intake. We also found a significant inverse association between the number of unique species consumed and body fat percentage.

This thesis' findings contrast with research conducted in the 1970s, where Damon (1974) suggested that rural Solomon Islanders were in "robust health," nutrition was largely adequate, and that little evidence of hypertension or coronary heart disease existed. However, more recent studies indicate that body fat percentage is rapidly rising in children and adults of all genders (Global Nutrition Report, 2020).

Ultra-processed foods were not as widely consumed in Solomon Islands as in more developed PSIDS or other countries such as the United States (Steele et al., 2016). However, data from this thesis suggest nutrition transitions are occurring within Solomon Islands and throughout Melanesia, which align with findings from the broader Pacific (Snowdon et al., 2013). Additionally, imported foods such as white rice and refined flour may not be considered ultra-processed foods (Monteiro et al., 2019), but tend to be higher in energy and lower in fibre, while also being lower in essential nutrients when compared to traditionally consumed staple starchy fruits and vegetables such as bananas and sweet potatoes.

It is important to note that rice, wheat flour, and vegetable oils (palm) have been recently fortified with essential nutrients in Solomon Islands as well as in many other PSIDS. Food fortification is a cost-effective strategy for mitigating numerous forms of malnutrition such as stunting and wasting (Muthayya et al., 2012). However, an overreliance on this strategy may accelerate overnutrition through the consumption of foods with high energy and sugar content that often displace traditional nutrient-rich foods, resulting in rises in NCDs.

Models predict that climate change will have an impact on staple crops such as rice and wheat by significantly reducing protein and micronutrient composition as atmospheric carbon dioxide rises globally (Zhu et al., 2018). Hence, populations that rely on single plant-based nutrients — commonly lower socioeconomic status groups — are expected to experience disproportional adverse impacts of these nutrient losses, aggravating existing and encouraging new cases of malnutrition. For example, nearly 600 million people, primarily in Southeast Asia, obtain more than 50% of their daily energy from rice alone. Rice and wheat are not widely produced in the Pacific and rely on international imports. From a global perspective, rice production is among the largest sources of plant-based methane emissions — a greenhouse gas 28 times more potent at trapping heat in the atmosphere than carbon dioxide — which should be an additional consideration when discussing future sources of sustainable carbohydrates (Minami & Neue, 1994).

The recent COVID-2019 pandemic has illuminated the fragility of global food systems and has impacted economic opportunity and food security within PSIDS (Farrell et al., 2020). Food systems, such as those in PSIDS, are particularly vulnerable due to their heavy reliance on imported foods (Galanakis, 2020). Therefore, future food system strategies, including the possibility of increasing national and regional food sovereignty, must consider long-term resilience in the face of climate changes and food system disruptions.

It is clear that when the diets of Indigenous peoples transition from local foods to industrially produced foods, the nutritional status and health of the populations decline (Kuhnlein & Burlingame, 2013). This study's findings from Solomon Islands align with trends from the broader Pacific, indicating that a nutrition transition is occurring. Along with nutrition transitions come increases in NCDs, which add economic burdens on individuals and governments. An emphasis on NCD prevention for children and high-risk adults would be the most cost-effective strategy (Snowdon et al., 2014). There is considerable research highlighting the value of local and healthy foods for improved diet quality and health (Golden et al., 2011; Powell et al., 2013).

6.1 Integrating Nutrition into Indigenous PSIDS Food Systems

According to the food system framework outlined by the High Level Panel of Experts (2017), numerous factors, such as inputs, supply/demand, drivers, investments, and policies, influence food systems (Fanzo et al., 2017). For PSIDS, primary change drivers of food systems are related to shifting sociocultural norms, urbanization, globalization, climate change, and external food system stressors such as the 2019 COVID-19 pandemic (Albert et al., 2020; CTA, 2020; Jupiter et al., 2014; Sievert et al., 2019). Using a food systems approach when designing interventions and policies can help to improve diet quality by increasing the availability, affordability, and acceptability of nutritious foods (Fanzo et al., 2017). To improve diet quality and food system resilience in PSIDS, food system drivers and investment levers must include local participation and knowledge and ensure the increased production of nutrient-dense foods that are ecologically suited for local and regional production (Albert et al., 2020). This thesis identified over 250 unique and locally available species and varieties, many of which are well-suited for scaling up nutrition and economic opportunities, including slippery cabbage (bele), wild fern (kasume), and ngali nuts

From agricultural inputs to market and retail sales, prioritizing nutrition and minimizing the decline of nutrients across the supply chain can help to ensure maximum nutrient quality reaches target communities. According to the focus group discussions, agrobiodiversity and associated knowledge within Solomon Islands' food systems is rapidly declining, and is projected to continue without interventions (Vogliano et al., 2020). Additionally, this study's findings suggest that food loss and waste related to weather, spoilage, and lack of preservation techniques were high in both rural and urban settings in Solomon Islands (Vogliano et al., 2020). These food loss findings have been confirmed by other studies that examined postharvest losses in the urban capital of Honiara, Solomon Islands (Steven Jon Rees et al., 2019), as well as in Fiji and Samoa (Underhill & Kumar, 2015; Underhill et al., 2017). Evidently, strategies to reduce these losses are critical for maximizing nutrient retention across the food system. Such strategies could include more modern techniques such as improved cold storage facilities and transportation to markets (Snowdon et al., 2010), as well as traditional techniques of local food preservation and processing like drying and smoking nuts, legumes, meat, and fish (Albert et al., 2020; Vogliano et al., 2020).

The findings from this thesis suggest that traditional knowledge is still valued by adults and youth and may help advance the cultivation of local agrobiodiverse food systems. If agrobiodiversity is scaled within Solomon Islands' food systems, it can positively impact the four primary dimensions of sustainable food systems as follows:

- **Economic** Agrobiodiversity can provide additional income generation opportunities for Indigenous peoples and help build stronger local and regional economies (Di Falco, 2012). For example, agroforestry systems can help build ecosystem services and protect the people from the adverse financial impacts of climate change (Auffhammer & Carleton, 2018; Nordhagen et al., 2017). Ngali nuts and copra are specific agri-food products in Solomon Islands produced using agroforestry systems, and packaged and sold to regional, national, and international consumers to support rural livelihoods.
- **Nutrition**: Solomon Islands and many PSIDS are biodiversity hotspots, containing vast genetic agri-food diversity. Diets with a wider range of essential nutrients, including vitamins, minerals, fiber, and phytochemicals, are well known to protect against disease and promote wellbeing (Jones, 2017; Zimmerer & De Haan, 2017). Focus group discussions identified 221 species and varieties of agrobiodiverse foods available for cultivation or wild collection, and based on 24hr MPR diet data, 87 were found to be utilised. Interestingly, those participants who consumed a wider diversity of species had a higher probability of achieving recommended nutrition intake and lower body fat percentage ($r2 = 0.205$; $p = 0.012$). Intentionally cultivating, processing, and promoting agri-food products to fill local nutrient gaps could help support local economies while ensuring access to year-round nutrient-rich foods.
- **Planetary**: Agrobiodiversity can provide crop resilience against climate changes such as droughts, heavier rains, pests, and diseases, while simultaneously strengthening ecosystem services (Matsushita et al., 2016). Melanesia and other PSIDS have long used agroforestry production systems, which current science supports as a leading strategy for adapting to climate change while supporting sustainable diet patterns (Shin et al., 2020). Findings from Chapter 3 indicate that climate change is directly impacting

Melanesians through changing weather patterns, decreased crop yields, and an increase in agricultural pests. Findings from this thesis indicate that rural farmers in the Solomon Islands do not utilize agrochemical inputs in their farming practices, but rather harness the power of agroforestry and diversified planting techniques. Since Indigenous people in Solomon Islands, and more broadly PSIDS, rely on ecosystem services for agricultural production, protecting land and ocean biodiversity must be prioritized. While Indigenous food systems are resilient, villagers do not feel adequately prepared to confront the adverse effects of climate change. Hence, additional efforts are needed to facilitate the supply and distribution of climate-resilient seeds and planting materials, as well as the provision of other adaptation strategies.

- **Sociocultural**: Agrobiodiversity preserves culturally significant and valuable traditional and Indigenous diet knowledge that can support Indigenous peoples in PSIDS (Nordhagen et al., 2017; Zimmerer, 2014). Indigenous knowledge can also inform global development strategies towards more sustainable and resilient food systems (Magni, 2017). This study's findings indicate that men, women, and youth value their traditional foods and would like to keep these foods as part of their food systems in the future, however due to the convenience of imported and ultra-processed foods, increase in population, transition to a cash-based economy, and the influence of globalization, traditional diets are being replaced by imported and ultra-processed foods.

Research findings from this thesis' scoping review indicates that there are opportunities to scale up nutrition education programming inclusive of traditional knowledge, sociocultural values, and nutritional sciences. Improving diet quality by facilitating behaviour changes requires concerted efforts on awareness, nutrition education, willingness to pay, and empowerment, particularly among women (Fanzo et al., 2017). Nutrition education by itself has mixed results on improving diets, but when combined with congruent food system changes like improved food environments or economic opportunities, the impact can be much more significant (McGill et al., 2015). Findings from the scoping review in Chapter 2 indicated that significant reductions in severe malnutrition were achieved through multifaceted intervention approaches that include nutrition education integrated with existing healthcare and agricultural systems. While women demonstrated a basic understanding of nutritional concepts, there is still an opportunity to explore if and how culturally-specific nutrition education can be integrated into exiting services such as media campaigns, nutritious school feeding programs, and national food-based dietary guidelines (Wilkins, 2005).

6.2 Policy levers & actions

Chapter 2's findings indicate that trade policies and agreements have accelerated the nutrition transition in the Pacific. Using the INFORMAS trade monitoring framework, researchers identified a strong correlation between Fiji's commitments to the World Trade Organization (WTO) and the unhealthy transitions of local food environments. There is a strong need to monitor the impacts of trade agreements in order to address food supply factors at the national level, thereby, ultimately contributing to the availability and nutritional quality of the national food supply (Amerita et al., 2017). Trade and policy, in conjunction with social and cultural changes, can play important roles in birthing solutions to unhealthy nutrition transitions. Specific policy strategies which could improve the sustainability of local food systems include aligning tariff schedules with the healthiness of foods, restricting or taxing unhealthy imports, investing in rural and agricultural development, and investing in the processing and export of healthy traditional foods (Thow, Heywood, et al., 2011).

When researchers modelled the cost and benefits of food policy interventions for both Fiji and Tonga in relation to their impact on NCD rates, the most effective intervention was cool storage facilities at all markets (Snowdon et al., 2011). However, this was also the costliest (1.6 million Fijian dollars the first year, and 100,000 every year after) solution, and therefore not recommended as the most cost-effective. The most effective policies were fiscal, of which the leading policy focused on reducing the import duties on fresh and frozen fruits and vegetables to 0%. Notedly, soft drink taxes have been imposed in four PSIDS, with aims of reducing the consumption of sugar-sweetened beverages. However, these have been met with mixed success, as lobbying from industry has reduced the overall tax rates (Thow, Quested, et al., 2011).

Melanesian countries are among the last remaining countries in the world where the traditional economy outweighs the cash economy in terms of providing livelihood—however, this is rapidly changing. Researchers argue that sustainable development requires new ways of integrating macroeconomic strategies and political institutions to work within existing communal structures and resource ownership (Addinsall et al., 2015). Agroecology has the potential to combine disciplines, including sociology, economics, agronomy, and ecology with a bottom-up approach (Addinsall et al., 2015).

Agricultural production makes up over 91% of the Solomon Islands' GDP (WTO, 2017). With 85% of the population relying on subsistence farming to some degree, opportunities to intensify production systems for both income and food and nutrition security are required. Agricultural intensification has historically focused on increasing yields of major staple crops, and this has resulted in numerous negative environmental, social, and nutritional trade-offs. Increasing yields alone may provide sufficient energy in the form of calories but does not address micronutrient deficiencies or environmental considerations. Sustainably intensifying healthy food production is one possible strategy to improve yields, incomes, and access to healthier foods choices – all while minimizing environmental impacts (Raneri & Vogliano, 2019). Increasing production for local and regional consumption can create pathways for niche value chains and income generation opportunities. One example is the local or regional processing of Vitamin A-rich crops into shelf stable complementary baby foods, which can be used as a year-round source of essential nutrients for vulnerable populations (Raneri & Vogliano, 2019). Different strategies are needed, depending on the context, particularly among rural versus urban populations to promote food production. For instance, rural populations have land and space to cultivate, collect, and sell agri-food products to support their livelihoods. Urban populations, however, often lack the space and time to grow and collect foods, and thus, rely on foods purchased from the markets and shops. As such, supporting diverse and healthy food value chains that flow from rural cultivation to urban markets provide an opportunity to build more sustainable food systems. To achieve healthier value chains, investments in infrastructure (i.e., roads, cold storage, improved market access) are required.

This thesis' findings suggest an inverse correlation between the quantity of dark green leafy vegetables consumed with body fat percentage and waist circumference. Local dark green leafy vegetables such as slippery cabbage were found to be critical sources of many nutrients for Indigenous Solomon Islanders and require less care due to their adaptation to local ecological conditions (Flyman & Afolayan, 2006). In fact, many underutilized agri-food varieties are culturally significant and are rich sources of missing essential nutrients. Another such example is the Fe'i banana found in many PSIDS, which are an excellent source of provitamin A and riboflavin (vitamin B2). Scaling cultivation and promoting the consumption of nutrient-rich foods like these bananas can help mitigate micronutrient deficiencies that lead to stunting and malnutrition (Daniells et al., 2014). Unfortunately, certain communities are battling with invasive species (i.e., African snails) which are challenging the cultivation of many nutrient-rich foods. If culturally accepted, African snails can be consumed, as they contain many essential nutrients missing from local diets (if properly prepared). Ultimately however, eradicating these invasive species is ideal to preserve traditional agri-food varieties.

Future strategies and policies which aim to improve the nutrition and health outcomes of Indigenous peoples in PSIDS should begin with the inclusion of traditional knowledge, values, and priorities. This thesis' findings indicate that convenience, affordability, access, and income generation opportunities are leading priorities for those in Solomon Islands and must be considered when building sustainable food systems. Despite recent trends, we found that both adults and children still enjoy traditional foods. Thus, there is a unique opportunity for small and medium sized enterprises to integrate traditional foods into convenient options for rural populations and transitioning urban populations with little access to arable land.

Globally, no country currently meets the basic dietary requirements for their constituents at a globally sustainable level (Appendix A). However, evidence is mounting that sustainable diets can and must be realized, inclusive of the four primary dimensions of sustainability: economic, nutrition, sociocultural, and planetary. Building sustainable food systems in nations like Solomon Islands requires coordinated multi-sectoral cooperation and action, including the integration of local perspectives, cultural values, and priorities. Indigenous food systems and associated knowledge, like those in PSIDS, can also provide many answers to concerns with modern-day industrial food systems in higher income countries. This study's findings have provided an opportunity for Indigenous leaders to share their knowledge and contribute to global discourses about improving the sustainability of global food systems.

6.3 Limitations

There are several limitations to this thesis. The cross-sectional, observational study sample sizes were small convenience samples, and do not represent all cultures or food systems within Solomon Islands. The primary researcher (PhD candidate) was a non-native and was not familiar with the local customs, culture, and language, which was partially mitigated by working with native dietitians and enumerators, but still had influence over the scope and analysis of this thesis. Future studies should be co-developed by native researchers to ensure local culture, customs, and values are integrated throughout the study design.

Nutrition composition tables which inform dietary intake assessments have not been conducted for most underutilized, wild, and traditional foods in PSIDS, leaving hundreds of food varieties' unique nutrient contributions unknown. Substituting for the closest available food provides the best estimates of local nutrient intakes, but updating the Pacific Island Nutrient Composition Tables Version 2 (Dignan et al. 2004) would improve the quality of analysis and agri-food-based interventions. While this thesis' findings indicate that there is significant correlation between agrobiodiversity and body fat percentage, both were also highly variable, suggesting the involvement of other cofounding variables.

6.4 Conclusion

To the researchers' knowledge, Indigenous Solomon Islands food systems, similar to many Indigenous Peoples' food systems, were largely sustainable prior to colonization and closely aligned with the four dimensions of sustainable food systems. However, findings from this thesis indicate that climate change, transitioning economies, and nutrition transitions from traditional diets are posing a new series of challenges. Specifically, climatic changes such as unpredictable weather patterns, stronger storms, and droughts are already causing food system disruptions among Indigenous Solomon Islanders.

This thesis supports the notion that Solomon Islands is a biodiversity hotspot, as we identified 250+ varieties of locally available agri-foods within one small rural village in the Western Province. We found that participants who consume a wider diversity of species, particularly dark green leafy vegetables, had a higher probability of achieving recommended nutrition intakes and a lower body fat percentage and waist circumference. This study's findings also suggest that rural and urban Solomon Island diets are becoming less diverse and more heavily reliant on ultra-processed foods, both of which are linked to nutrient deficiencies and the multiple forms of malnutrition. This was found to be particularly true for urban populations. Nutrition transition shifts away from traditional diets and towards imported and ultra-processed foods such as white rice and instant noodles provide economic advantages, reduced cooking times (convenience), and enjoyable tastes. However, the trade-offs from these dietary shifts are already becoming apparent through the erosion of Indigenous knowledge and the overconsumption of poor-quality foods which lead to higher rates of NCDs.

Indigenous Melanesians live within one of the most biodiverse regions in the world. Most men, women, and youth who participated in this study value their traditional agrobiodiversity knowledge and would likely respond well to policies and programs that aim to help retain it. Importantly then, future strategies should be participatory and inclusive of Indigenous Peoples and their traditional knowledge, while also meeting the demands of modern life, to ensure sustainable and resilient future food systems in Solomon Islands and Melanesia.

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Appendix A: Health and other impacts of community food production in Small Island Developing States: a systematic scoping review [Published PDF]

Article Title

Citation

Haynes E, Brown CR, Wou C, Vogliano C, Guell C, Unwin N, the Community Food and Health Project. Health and other impacts of community food production in Small Island Developing States: a systematic scoping review. Rev Panam Salud Publica. 2018;42:e176. https://doi.org/10.26633/RPSP.2018.176

Candidate involvement

Co-author: Candidate contributed 25% to the scoping review through examining 50% of the systematically collected literature using RedCap software.

Purpose for inclusion

This systematic scoping review assesses knowledge surrounding community food production in small island developing states globally. The findings suggest a need for additional work in understanding the multiple dimensions of sustainable food systems in island nations, with an emphasis on linkages between production, market sales, consumption, and humans and planetary health.

Copyright found in Appendix K

Review

Pan American Journal of Public Health

Health and other impacts of community food production in Small Island Developing States: a systematic scoping review

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ABSTRACT

Objective. *To explore what is known on community-based food production initiatives (CFPIs) in Small Island Developing States, particularly the health, social, economic, and environmental impacts of and on CFPIs.*

Methods. *This was a systematic scoping review using 14 electronic databases to identify articles published from 1997 to 2016 on the topic of CFPIs in Small Island Developing States. From 8 215 articles found, 153 were eligible and abstracted. Analysis focused on geographic location, typology, methodology, study design, theoretical frameworks, and impacts.*

Results. *Most research was conducted in the Pacific or Caribbean (49% and 43% of studies, respectively) and primarily focused on fishing and crop farming (40%, 34%). Findings indicate a predominance of research focusing on the environmental impact of marine and coastal resources on CFPIs, and very limited evidence of CFPI impact on human health, particularly nutrition and diet-related outcomes. There was a lack of explicit theoretical frameworks to explain the impacts of CFPIs.*

Conclusions. *Evidence of impacts of CPFIs in Small Island Developing States is limited and the approaches taken are inconsistent. This review demonstrates the need and provides a basis for developing a coherent body of methods to examine the impacts of CFPIs and provide evidence to guide policy, especially as it relates to health.*

Keywords Food and nutrition security; food production; agricultural cultivation; animal husbandry; fishing industry; noncommunicable diseases; environment and public health; Pacific Islands; Caribbean region.

Small Island Developing States (SIDS) have some of the highest rates of noncommunicable diseases (NCDs) globally, particularly obesity, diabetes, and related NCDs (1 – 3). Major determinants of the NCD burden in these countries include extensive changes to food systems, which are attributed to globalization and has led to a "nutrition transition" (4 – 6). Across SIDS and low- and middle-income countries (LMICs) more widely, this transition is characterized by a dietary shift away from fruits, vegetables, and high-fiber staples, and towards energy-dense and highly processed foods. Related factors are poor agro-ecological conditions for agriculture; poor storage and transport leading to wasteful supply chains; export of local food products to other countries; reliance on food imports; and limited technology and know-how (7). Thus, many SIDS lack food sovereignty and are vulnerable to food insecurity. Increasing local food production, particularly of non- or minimally-processed foods, is seen as a pre-requisite to effective long-term NCD prevention.

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Community-based food production initiatives (CFPIs) is one approach to improving food and nutritional security and sovereignty (7 – 9). For this study, CFPIs were defined as being locally owned and managed and producing fresh or minimally-processed foods for local consumption (8 – 10). Previous reviews on the relationships between local food production and health have found limited evidence. Most studies have focused on maternal and child health; few have examined nutrition from the perspective of NCDs (11 – 14). Additionally, the majority of research has focused on Sub-Saharan Africa and South Asia (12). Given the heightened vulnerability of SIDS, they are a key location for assessing CFPIs.

This study is nested within a larger project aiming to develop a theoretical framework and methods for evaluating the impact of CFPIs on risk factors for NCDs, social and economic well-being, and the environment (15). This systematic scoping review was undertaken as a first step. The inclusive and comprehensive nature of scoping reviews facilitates the inclusion of a range of study designs; this is particularly useful when applied to underexplored or heterogeneous topics such as this to inform further research, practice, and policy (16 – 18).

The aim of this systematic scoping review was to identify studies that report the health, social, economic, and environmental impacts of CFPIs in SIDS, and to explore what is known about those CFPIs, including their number, distribution, and characteristics. Specific objectives were to: (i) identify the study designs and data collection methods used to investigate the health, social, economic, and environmental impacts of CFPIs; (ii) construct a typology of these CFPIs; (iii) identify theoretical causal frameworks for impacts of these CFPIs; and (iv) identify the health, social, economic, and environmental impacts on CFPIs.

MATERIALS AND METHODS

Methodological framework

Scoping reviews are used to map the concepts underlying a research area and the main sources and types of evidence available (19). They are increasingly used in the health and social sciences. However, to address criticism that their methodological approaches and reporting are inconsistent, a more systematic and transparent approach has been proposed (20 – 23) and an extension to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) for scoping reviews is being prepared (24). The present study followed this systematic approach, including reporting of findings according to general PRISMA guidance, when appropriate.

In keeping with scoping review methodology, the protocol was developed iteratively and informed by the results of initial literature searches and consultation with the wider project team. The full protocol has been published by University of Cambridge's Medical Research Council Epidemiology Unit (15).

Definitions of key terms

Owing to the absence of a universally-recognized definition and to the breadth of the research question, an iterative approach was applied to defining CFPIs. The NOVA classification was applied to define fresh and minimally-processed foods (25):

- **Community food production initiative**: owned, organized, and managed locally, and producing either fresh or minimally-processed food for local consumption.
- **Fresh food**: 'unprocessed' or 'natural' edible parts of plants (seeds, fruits, leaves, stems, roots) or animals (muscle, offal, eggs, milk), as well as fungi, algae, and water, after separation from nature (25).
- **Minimally-processed food**: natural foods altered only by processes such as removal of inedible or unwanted parts, drying, crushing, grinding, fractioning, filtering, roasting, boiling, pasteurization, refrigeration, freezing, placing in containers, vacuum packaging, or non-alcoholic fermentation, without the addition of substances to the original food (25).
- **Locally owned and managed initiatives**: food production owned and managed within that SIDS.
- **Food produced for local consumption**: food produced for consumption within that SIDS.

Identifying studies

A systematic and extensive search was conducted on 2 – 4 August 2017 in the following databases: MEDLINE® (U.S. National Library of Medicine, Bethesda, Maryland, United States), Excerpta Medica Database (Elsevier, Amsterdam, Netherlands); Cumulative Index of Nursing and Allied Health Literature (EBSCO Publishing, Ipswich, Massachusetts, United States); Scopus (Elsevier, Amsterdam, Netherlands); Conference Proceedings Citation Index (Clarivate Analytics, Philadelphia, Pennsylvania, United States); Social Science Citation Index – Social Science and Humanities (Clarivate Analytics, Philadelphia, Pennsylvania, United States); Arts & Humanities Citation Index (Clarivate Analytics, Philadelphia, Pennsylvania, United States); Emerging Sources Citation Index (Clarivate Analytics, Philadelphia, Pennsylvania, United States); Applied Social Sciences Index and Abstracts (ProQuest, Ann Arbor, Michigan, United States); Econlit (American Economic Association, Nashville, Tennessee, United States); Agricultural Online Access (United States National Agriculture Library, Beltsville, Maryland, United States); The International System for Agricultural Science and Technology (Food and Agriculture Organization of the United Nations, Rome, Italy); Western Pacific Region Index Medicus (World Health Organization Western Pacific Regional Office, Manila, Philippines); and Latin American and Caribbean System on Health Sciences Information (Pan American Health Organization/World Health Organization, São Paulo, Brazil). Database selection was informed by the systematic review protocol of Durao and colleagues (12) on food security in LMICs and was intended to cover major sources of health, social, economic, environmental, and agricultural sciences.

The search was not restricted by language, but it did exclude articles published before January 1997 and after December 2016. The SIDS included were those listed by the United Nations, with the addition of Tokelau (26). Search terms are listed in the review protocol (15).

Study selection

Identified citations were downloaded into an online bibliographic database, Rayyan (Qatar Computing Research Institute, Data Analytics, Doha, Qatar; 27). Title and abstracts were screened independently in duplicate (EH, CB). Articles were considered eligible for inclusion if they met three criteria: (i) concern at least 1 of the 58 SIDS countries/territories; (ii) report on CFPIs (as previously defined);

and (iii) report on health, social, economic, or environmental impacts of/on CFPIs. When information was insufficient, an inclusive approach was taken by including the citation for full-text review. Conflicts were resolved by discussion with a third reviewer (CG).

Data charting

Full-text screening followed a step-wise approach (Figure 1). Each record was examined chronologically as follows: (i) Does it involve food production in a SIDS?; (ii) Is the food production managed/owned locally?; (iii) Is the food produced predominantly for local consumption?; and (iv) Does it discuss impacts of/on the CFPI? Only articles that were affirmative ("yes") for all four screening questions were included; those for which the answer was "unsure" were excluded.

Full-text screening and data abstraction were performed by four independent reviewers (CB, CW, EH, NU); 10% of randomly-selected articles were checked by a fifth reviewer (CV) to test the reliability of data abstraction. Inconsistencies were resolved by group discussion.

A data abstraction form was iteratively developed in REDCap© 7.3.4 (Vanderbilt University, Nashville, Tennessee, United States), a secure online data collection platform (16). Records that reported the impacts *of* CFPIs (Objective A) were abstracted into that form; while records that reported the impacts *on* CFPIs (Objective D) were abstracted using a simple data abstraction form developed in Microsoft Excel™ (Microsoft Corp., Redmond, Washington, United States).

Data synthesis

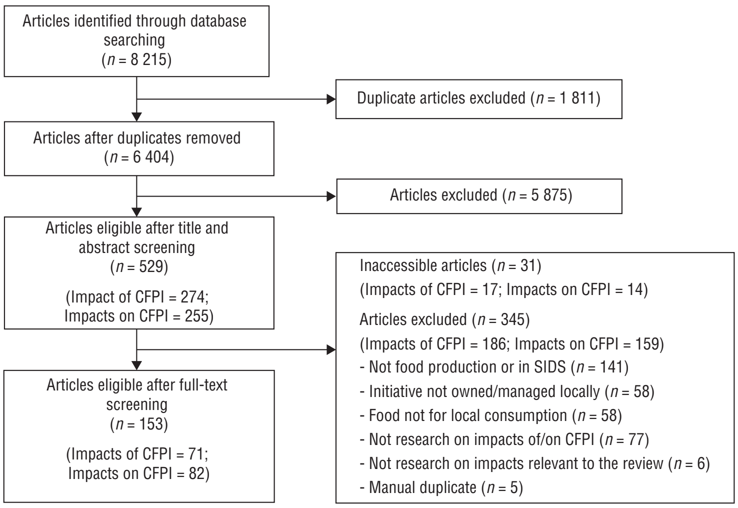
Impacts of CFPIs, impacts on CFPIs, and measured outcomes of impacts on CFPIs were organized into a coding framework to assist with analysis (available from the corresponding author upon request). Findings are reported as a qualitative narrative, with quantities tallied where appropriate. As is the case for scoping reviews, study quality was not assessed nor were meta-analyses performed (23).

RESULTS

Of 8 215 records identified, 153 studies (S1-S153) met the eligibility criteria and were included in the review (Figure 1). The complete bibliographic list of these articles (S1 – S153) is available as Annex 1.

Studies focused on 42 of the 58 SIDS countries and territories. Despite this wide geographic range, 23 of the SIDS contributed only 3 or fewer studies to this review. Most of the research was conducted in the Pacific (n = 75 studies; 49%) and Caribbean regions (n = 66; 43%), predominantly Papa New Guinea (n = 16), Solomon Islands (n = 16), and Cuba (n = 15). A range of study designs were employed to evaluate the impacts of/on CFPIs, and the majority reported the results of primary research (n = 125; 82%) derived from a cross-sectional design (n = 88; 58%). Primary research studies commonly applied quantitative (n = 60; 48%) and mixed methods (n = 42; 34%) approaches; qualitative approaches (alone) were employed in 23 studies (18%; Figure 2).

FIGURE 1. Flowchart of the literature search and screening



Source: Prepared by the authors, using study data.
Note: CFPI – community food production initiative; SIDS – small island developing state.

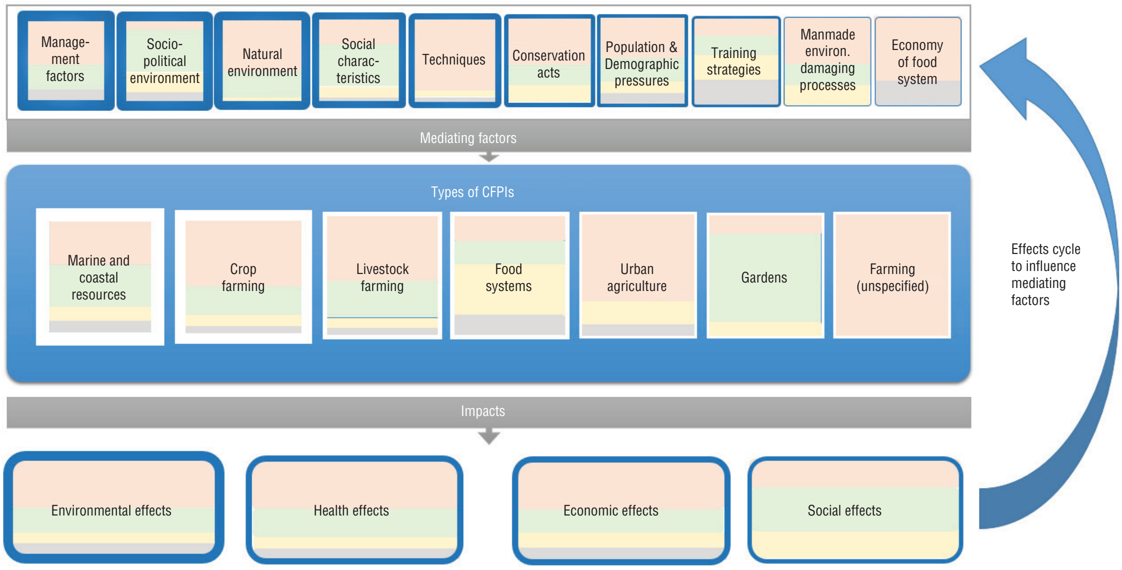
Types of CFPIs

Most studies reported evaluations of current practices, rather than novel initiatives or programs. Five major types of CFPIs were identified: marine and coastal resources, farming (including crop and livestock subgroups), gardens, urban agriculture, and food systems. CFPIs classified as marine and coastal resources included food production techniques such as fishing, coastal foraging, and aquaculture. These initiatives mainly concerned small-scale, subsistence or artisanal fishing, and included initiatives such as village-run fishing cooperatives (S88) and community-based resource monitoring and provisioning services (S3). Garden initiatives included community, home, and school gardens. Urban agriculture initiatives were reported in highly urbanized areas of Cuba and Singapore. One of the CFPIs classified as food systems reported on wider policy initiatives to alter food environments, such as increasing public market size and reducing barriers to roadside vending of local produce in Fiji and Tonga (S126). While there is a clear emphasis on fishing in the Pacific and farming in the Caribbean (Table 1), the range of their impacts (health/social/economic/environmental) was otherwise well distributed in both regions.

Impacts of CFPIs

Most studies examining impacts of CFPIs focused on the environmental impact (n = 47); their social impact (n = 23) was the least examined (Table 2). Studies that evaluated the impacts of CFPIs on human health were of particular interest to this review; 35 such studies were identified. These were predominantly quantitative or mixed-methods studies of marine and coastal resources (n = 11) or farming (n = 15), with few reporting garden initia-

FIGURE 2. Distribution and interlinkage of impacts of and on community food production initiatives (CFPIs), as described by the included studies conducted in SIDS in 1997–2016



Source: Prepared by the authors, using study data.
Note: Box border width indicates proportion of included studies. indicates quantitative; indicates mixed method; indicates qualitative; indicates other.

TABLE 1. Matrix of studies conducted in SIDS in 1997–2016, by type of community food production initiative (CFPI) and by region

		Type of CFPI							
		Marine and coastal resources	Crop farming	Livestock farming	Farming - unspecified	Gardens	Urban agriculture	Food systems	**Total**
Region	Caribbean	16	28	13	2	2	6	4	**71**
	Pacific	41	24	1	1	5	0	7	**79**
	Atlantic, Indian Ocean, Mediterranean and South China Sea	8	3	0	0	0	2	0	**13**
	Total	**65**	**55**	**14**	**3**	**7**	**8**	**11**	

Source: Prepared by the authors, using study data.
Note: Numbers denote number of studies, with overlap between types of community food production initiatives where necessary. The darker the blue, the higher number of studies.

tives (n = 5) or urban agriculture (n = 4). Health impacts coded, in order of frequency, were: agricultural production/catch/yield, dietary consumption, pollutants (water/air/soil contamination; pesticides), nutritional composition (nutritional value/mineral content), anthropometric (e.g., weight, body fat), biomedical (e.g., blood glucose, triglycerides), medicinal, psychological/well-being, communicable illnesses, and noncommunicable diseases.

Of these 35 studies reporting the human health impacts of CFPIs, only 7 implemented and evaluated a community food production intervention/program (most in the Pacific). These applied quantitative (n = 3) and mixed-methods (n = 4) approaches to interventional study design and evaluated health-related impacts of gardens (n = 3), crop farming (n = 3), and marine and coastal resources (n = 1). Data collection instruments included 7-day food frequency questionnaires and 24-hour recall to report health impacts evaluated as dietary outcome measures, namely dietary intake and nutritional composition of the diet (S61, S76, S111, S148). Biomedical and anthropometric measures were reported as health-related outcomes by 1 study (S76), specifically body mass index, waist circumference, blood pressure, and blood glucose. Three of the interventional studies reported productivity as an outcome, particularly the contribution to subsistence and food security in the Solomon Islands, Papa New Guinea, and Trinidad and Tobago (S66, S119, S128).

The remaining 27 non-interventional studies that reported human health impacts evaluated the following measures: dietary intake (S41, S63, S71, S87); anthropometric measures (S77, S95); communicable disease, predominantly related to pollutants (S13, S86, S135); and mental health and wellbeing (S41, S108). Two articles reported increases in heart disease, hypertension, diabetes, obesity, and cancers following a nutrition transition from local food consumption towards imported foods (S34, S134). However, a large proportion of these studies (n = 13; 38%) reported the health impact of CFPIs as increased agricultural productivity, and thus, improved food security (S3, S20, S58, S80, S82, S88, S97, S98, S130, S132 – 134).

Environmental impacts of CFPIs were the most commonly reported type of impact. Environmental impacts coded, in order of frequency, were: conservation/sustainability (including biocapacity),

TABLE 2. Matrix of studies conducted in SIDS in 1997–2016 examining impacts *of* and *on* community food production initiatives (CFPIs)

		Type of CFPI							
		Marine and coastal resources	Crop farming	Livestock farming	Farming - unspecified	Gardens	Urban agriculture	Food systems	**Total**
Impact of CFPI	Health	11	12	3	1	5	2	1	**35**
	Social	9	5	3	1	4	0	1	**23**
	Economic	15	9	1	0	2	3	1	**31**
	Environment	24	13	3	1	2	3	1	**47**
	Total impacts of CFPIs	**59**	**39**	**10**	**3**	**13**	**8**	**4**	
Impact on CFPI	Socio-political environment (higher level)	5	5	2	0	0	1	5	**16**
	Management factors (lower level)	10	9	0	0	0	1	1	**20**
	Training/strategies	1	3	0	0	1	0	2	**6**
	Conservation acts	8	0	0	0	0	0	0	**8**
	Social characteristics	7	4	0	0	0	0	4	**13**
	Population/demographic pressures	2	4	0	0	0	0	2	**7**
	Economy of food system (individual level)	1	1	0	0	0	0	1	**3**
	Natural environment	7	6	0	0	0	0	1	**13**
	Man-made environmentally-damaging processes	2	0	1	0	0	1	0	**4**
	Techniques	2	4	3	0	0	1	0	**10**
	Other	0	1	1	0	0	0	0	**2**
	Total impacts on CFPI	**45**	**37**	**7**	**0**	**1**	**4**	**16**	
	Total	**104**	**76**	**17**	**3**	**14**	**12**	**20**	

Source: Prepared by the authors, using study data.
Note: Numbers denote number of studies, with overlap between types of community food production initiatives where necessary. The darker the green, the higher number of studies.

agricultural production/catch/yield, pollutants (e.g., water/air/soil contamination; pesticides), soil quality, CO_2 savings, energy efficiency, and climate change. In particular, the environmental impact of fishing was predominantly explored ($n = 25$; 43% of those regarding marine and coastal resources). Existing catch data from fisheries was commonly utilized to determine conservation-related environmental impacts of fishing practices, and in these cases, official data reports were compared to evidence derived from the grey literature and local expert knowledge (S153). Spatial analysis of land use was used to explore impacts on water quality (S140). Interviews and field observations were also used to explore environmental impacts or stakeholder perceptions of such (S25, S26, S41, S49).

Social and economic impacts were assessed largely through interviews, focus groups and a variety of cross-sectional surveys. Specific to social impacts, studies largely employed ethnographic approaches (S52, S61, S67, S88, S121, S123) and one study drew upon visual techniques, i.e., mapping, participatory photography, and photo elicitation (S93). Social impacts coded, in order of frequency, were: knowledge, satisfaction/enjoyment (life or job), social participation/interaction, reliance and resilience (self or community), living conditions/dynamics, gender roles, values (social/cultural, equity, identity), relationships, attitudes (acceptability, empowerment), poverty, and change (infrastructure). Economic impacts coded, in order of frequency, were: income/subsistence (e.g., sales, revenue, importance to income), agricultural production/catch/yield, expenditure/cost, profitability, technological innovation, and economic resilience.

Given their wide reach, studies that reported agricultural production/catch/yield impacts and pollutants were categorized as multiple impact types depending on the specifics of each study.

Impacts on CFPIs

The reports of studies concerning impacts on various types of CFPIs (Table 3) also reflected the predominance of research on marine and coastal resources and farming. The most commonly explored impacts were management factors ($n = 20$; 20%) and socio-political environment ($n = 16$; 16%). The impacts of conservation acts, such as Marine Protected Areas and community provision interventions on fishing, were also frequently reported.

Measured outcomes of the impacts on CFPIs indicate the inherently cyclic nature of impacts and outcomes (Table 3). Food security was the most frequently reported outcome among these studies ($n = 108$; 60%), and not surprisingly, given the inclusion criteria for this review, food production specifically was most widely reported as an indicator of food security. Among other outcomes, conservation and sustainability were highly reported, as were those related to social and economic environments. There is a clear cyclic interlinkage between the impacts of different types of CFPIs and the factors that impact on them (Figure 2).

Theoretical frameworks

There was a general paucity of explicit theoretical frameworks or logic models reported by authors to explain how CFPIs might bring about health, social, economic, or environmental change. Since this systematic scoping review was particularly interested in frameworks and models that might explain underlying mechanisms or causal relationships

TABLE 3. Matrix of studies conducted in SIDS in 1997–2016 examining impacts on community food production initiatives (CFPI), by measured outcomes

		Mediating factor										
		Socio-political environment (higher level)	Management factors (lower level)	Training/ strategies	Conservation acts	Social characteristics	Population/ demographic pressures	Economy of food system (individual level)	Natural environment	Man-made environmentally-damaging processes	Techniques	**Total**
Impact outcome measured	Food security (unspecified)	3	3	1	0	3	2	1	2	0	1	**16**
	Food production	4	7	1	3	4	3	1	4	1	6	**34**
	Food availability	4	4	1	1	3	2	1	2	0	1	**19**
	Food access	3	3	1	2	4	2	1	1	1	1	**19**
	Subsistence/ resilience	2	1	2	0	2	2	1	1	0	1	**12**
	Food consumption	2	1	1	0	2	1	1	0	0	0	**8**
	Social	4	4	3	0	1	1	0	0	0	0	**13**
	Economic	3	5	1	1	2	1	0	2	0	0	**15**
	Conservation/ sustainability	4	3	1	2	4	2	0	2	2	1	**21**
	Practice	4	2	3	2	3	2	1	2	0	1	**20**
	Risk prevention	0	0	0	0	0	0	0	0	0	3	**3**
	Total	**33**	**33**	**15**	**11**	**28**	**18**	**7**	**16**	**4**	**15**	

Source: Prepared by the authors, using study data.
Note: Numbers denote number of studies, with overlap between types of community food production initiatives where necessary. The darker the green, the higher number of studies.

between CFPIs and impacts, descriptive explanations were extracted from these studies. Implicit theories of change were more widely explored for social impacts than other types of impacts. Assumed relationships between CFPIs and social impacts included their facilitation of community resilience, knowledge, cooperation, and participation (S23, S77, S149). The social benefit of local food production was attributed to women's participation in farming in Timor-Leste (S26) and to household subsistence in Comoros (S67). Garcia-Quijano and colleagues (S52) theorized that the satisfaction and enjoyment experienced through food production promote values of independence and family time in Puerto Rico, which are perhaps more important in SIDS communities than earning a substantial, steady salary. One study attributed Fijian fisheries' poor financial returns to narrow management style, in particular an "imposition of business practices and perceptions on how it ought to function [solely] as a profit maximizing venture" (S88). Although few studies reported health impacts of CFPIs, increased physical activity and a dietary shift away from imported processed foods to local produce were theorized to bring about health benefits associated with local agriculture in Samoa (S77).

DISCUSSION

This systematic scoping review maps out what is known on CFPIs in SIDS, i.e., their number, distribution, characteristics, and impacts on health, social and economic well-being, and the environment, as well as the impacts affecting CFPIs themselves. Though the distribution of research across SIDS is uneven, the publication span of 72% of the 58 countries/ territories is indicative of a growing interest in and recognition of the importance of these types of initiatives for food security; health, social, and economic well-being; and the environment in SIDS.

A predominance of the research focused on marine and coastal resources in the Pacific and crop farming in the Caribbean, evaluating the environmental impacts of both. Generally, there was an even distribution across the four impact domains (Table 2). However, only 7 of the 35 studies that examined health impacts evaluated the implementation of targeted food production programs on humans. Of studies reporting impacts on CFPIs, the most commonly reported mediating factors (management factors, socio-political environment, and natural environment) and outcomes (food production and conservation/sustainability) reflect a relatively wide scope and an intertwining of environmental and climate change issues with food security and policy (Figure 2).

These key findings indicate a number of gaps in the literature. It is not surprising that a high proportion of these studies were focused on fishing activities—a readily available and priority resource in SIDS. However, this predominance might simply reflect greater research into environmental issues, such as marine conservation, fishing stocks, and coastal reef health, than food production in these countries, with the latter simply encompassed within these environmental studies. Regardless, this predominance illustrates a focus on climate change, resource capacity, and sustainability within a food security landscape, which have been emphasized before in SIDS (28, 29).

We also found that that the impacts of and on local food production are largely reported in the context of environmental issues. Recognizing not only the interlinkage, but also the cyclical associations between the environmental impacts on food production, and the health, social, economic, and environmental outcomes of CFPIs that are impacted is crucial and integral to informing future initiatives.

A food systems approach is integral to facilitating interdisciplinary action to improve food security (28). Thus, the dearth of evidence regarding nutrition-related health impacts of CFPIs and of changing local food systems in SIDS to enhance local consumption is important to note. In the wider context of LMICs, household agricultural strategies have increased micronutrient intake among women and children (30); however, there is limited evidence of their subsequent impact on micronutrient status, NCDs, or the impact of whole community initiatives on the total, local population (30). Therefore, it seems likely that the research gap regarding nutrition-related health impacts of local food production is not unique to SIDS, but exists in the wider context of LMICs (12), and possibly in high-income countries as well (31). The findings of ongoing systematic reviews should provide valuable insights into the impact of community food interventions on food security in LMICs and high-income countries (12, 31). In the context of SIDS, our further research following this review aims to respond to this gap by providing evidence around local dietary patterns, food sourcing, and food insecurity in two SIDS settings, in an effort to develop evaluation tools for CFPIs in other settings (15).

While identifying the distribution and gaps in research, our typology of initiatives demonstrates alternative opportunities for community food production, such as under-researched gardens and urban agriculture (Table 2). This raises questions as to whether countries are taking advantage of these to boost local food production. It also challenges those that plan to use robust (experimental or quasi-experimental) study designs to evaluate the health impacts of CFPIs.

Limitations. This review illustrates an original, systematic, and interdisciplinary approach to examining the breadth of literature around impacts of and on CFPIs in SIDS. However, common to scoping reviews (21, 23), the iterative approach and breadth of the topic gave rise to various interpretations of what was "relevant" in the context of this research. This was further impacted by the lack of universal definitions for key terms and limited detail provided by authors. The ambiguity led to discrepancies in coding between the reviewers, which were resolved during frequent moderation, but had implications on the time taken to complete the review. The lack of theoretical frameworks reported for the impacts of CFPIs limited discussion on the third objective of this review. This is likely due to the varied disciplines of the included records, together with the understanding that most health interventions are not based on standardized theory, and those that are theory-based, apply only parts of the underlying theory (32). Finally, while our search methods aimed to identify published papers and reports, it is possible that other relevant initiatives were not published or that the search terms failed to identify them.

Conclusions

This systematic scoping review maps the evidence on CFPIs to support improved nutrition, prevent NCDs, and bring about other social, economic, and environmental benefits in SIDS populations. Seven types of CFPIs were identified in this review and a range of mixed methodologies were reported, varying based on type of impact reported. Primary evidence of nutrition and NCD-related health impacts of CFPIs is limited, but there is a predominance of research into environmental impacts. Regardless of impact, causal frameworks were rarely cited.

An interdisciplinary approach to research, maintaining a cyclic interrelation between food production and its wider environmental, economic, and social influences, is important to addressing two major global health topics: NCDs and climate change. As research in this area grows, there is an opportunity to develop coherent methodological approaches for monitoring and evaluating CFPIs and their associated impacts. Such approaches should be under-pinned by sound causal frameworks that are tested and refined as new evidence accrues.

Author contributions. EH and CRB contributed to data extraction, evidence mapping, wrote the first draft, and editing. CW and CV contributed to data extraction, evidence mapping, and editing. NU conceived the original idea; NU and CG contributed to the study design, data extraction, evidence mapping, and editing. All authors approved the final version.

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Conflict of interests: None declared.

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Disclaimer. Authors hold sole responsibility for the views expressed in the manuscript, which may not necessarily reflect the opinion or policy of the *RPSP/PAJPH* and/or PAHO.

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RESUMEN

Impacto en la salud y otros ámbitos de la producción comunitaria de alimentos en los pequeños Estados insulares en desarrollo: una revisión sistemática exploratoria

Objetivo. Explorar las iniciativas de producción de alimentos basadas en la comunidad (CFPI, por sus siglas en inglés) en los pequeños Estados insulares en desarrollo, en particular su impacto sanitario, social, económico y ambiental.
Métodos. Se realizó una revisión sistemática exploratoria usando 14 bases de datos electrónicas para identificar artículos publicados entre 1997 y 2016 sobre las CFPI en los pequeños Estados insulares en desarrollo. De 8 215 artículos encontrados, 153 fueron elegibles y resumidos. El análisis se centró en la ubicación geográfica, el tipo de iniciativa, la metodología, el diseño del estudio, el marco teórico y el impacto.
Resultados. La mayoría de las investigaciones se realizaron en el Pacífico o el Caribe (49% y 43% de los estudios, respectivamente) y se centraron principalmente en la pesca y el cultivo (40%, 34%). Los hallazgos indican un predominio de investigaciones centradas en el impacto ambiental de los recursos marinos y costeros en las CFPI, y una evidencia muy limitada del impacto de las CFPI en la salud humana, en particular en resultados relacionados con la nutrición y la dieta. Faltan marcos teóricos explícitos para explicar el impacto de las CFPI.
Conclusiones. La evidencia del impacto de las CPFI en los pequeños Estados insulares en desarrollo es limitada y los enfoques adoptados son inconsistentes. Esta revisión demuestra la necesidad de efectuar estudios y proporciona una base para desarrollar métodos coherentes para examinar el impacto de las CFPI y proporcionar evidencia para guiar las políticas, especialmente las relacionadas con la salud.

Palabras clave Seguridad alimentaria y nutricional; producción de alimentos; cultivos agrícolas; crianza de animales domésticos; industria pesquera; enfermedades no transmisibles; medio ambiente y salud pública; Islas del Pacífico; Región del Caribe.

RESUMO

Impacto na saúde e outras áreas da produção alimentar comunitária em pequenos Estados insulares em desenvolvimento: uma revisão sistemática exploratória

Objetivo. Explorar iniciativas de produção alimentar baseada na comunidade (CFPI) em pequenos Estados insulares em desenvolvimento, particularmente seu impacto na saúde, social, econômico e ambiental.
Métodos. Uma revisão sistemática exploratória foi realizada utilizando 14 bases de dados eletrônicas para identificar artigos publicados entre 1997 e 2016 sobre CFPI em pequenos Estados insulares em desenvolvimento. Dos 8 215 artigos encontrados, 153 foram elegíveis e resumidos. A análise centrou-se na localização geográfica, no tipo de iniciativa, na metodologia, no desenho do estudo, no referencial teórico e no impacto.
Resultados. A maior parte da pesquisa foi realizada no Pacífico ou no Caribe (49% e 43% dos estudos, respectivamente) e se concentrou principalmente na pesca e na agricultura (40%, 34%). Os resultados indicam uma predominância de pesquisas focadas no impacto ambiental dos recursos marinhos e costeiros na CFPI, e evidências muito limitadas do impacto das CFPI na saúde humana, particularmente nos resultados relacionados à nutrição e dieta. Não existem quadros teóricos explícitos para explicar o impacto das CFPI.
Conclusões. A evidência do impacto das CPFI em pequenos Estados insulares em desenvolvimento é limitada e as abordagens adotadas são inconsistentes. Esta revisão demonstra a necessidade de estudos e fornece uma base para o desenvolvimento de métodos coerentes para examinar o impacto das CFPI e fornecer evidências para orientar políticas, especialmente aquelas relacionadas à saúde.

Palavras-chave Segurança alimentar e nutricional; produção de alimentos; cultivos agrícolas; criação de animais domésticos; indústria pesqueira; doenças não transmissíveis; meio ambiente e saúde pública; Ilhas do Pacífico; Região do Caribe.

Appendix B: Sustainable diets and Food-Based Dietary Guidelines [Published PDF]

Book Title: Advances In Food Security And Sustainability

Chapter Title: Sustainable diets and Food-Based Dietary Guidelines

Authors: Rebekah Jones, Christopher Vogliano and Barbara Burlingame

ISBN: 9780128176986

Pages: 158 - 171

Year: 2019

Link: https://www.cabi.org/nutrition/ebook/20183377470

Candidate involvement:

35% contribution to article, where my role was to gather and synthesize data on global food based dietary guidelines in regards to sustainability, and create comparative tables for use within the publication.

Purpose for inclusion: This chapter introduces the concepts of sustainable diet patterns and how these patterns are represented in Food-based dietary guidelines from select countries globally. Similarities and differences between countries are displayed in Tables 16.1 and 16.2.

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GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the candidate and the candidate's Primary Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of candidate:	Christopher Vogliano
Name/title of Primary Supervisor:	Prof Jane Coad
Name of Research Output and full reference:	
Jones, R., Vogliano, C., Burlingame, B. (2018). Sustainable Diets and Food-based Dietary Guidelines. In Sustainable Diets: Linking Nutrition and Food Systems (Eds. Burlingame & Dernini). Centre for Agriculture and Bioscience International (CABI), Oxfordshire, UK.	
In which Chapter is the Manuscript /Published work:	Appendix A
Please indicate:	
• The percentage of the manuscript/Published Work that was contributed by the candidate:	35%
and	
• Describe the contribution that the candidate has made to the Manuscript/Published Work:	
35% contribution to article, where my role was to gather and synthesize data on global food based dietary guidelines in regards to sustainability, and create comparative tables for use within the publication.	
For manuscripts intended for publication please indicate target journal:	
Candidate's Signature:	Chris T Vogliano
Date:	2 AUGUST 2020
Primary Supervisor's Signature:	Jane Coad
Date:	24th August 2020

(This form should appear at the end of each thesis chapter/section/appendix submitted as a manuscript/ publication or collected as an appendix at the end of the thesis)

GRS Version 4– January 2019

Appendix C: Can Leveraging Agrobiodiverse Food Systems Help Reverse the Rise of Malnutrition in Pacific Small Island Developing States (PSIDS)? [Conference Proceedings]

Abstract Title: Can Leveraging Agrobiodiverse Food Systems Help Reverse the Rise of Malnutrition in Pacific Small Island Developing States (PSIDS)?

Status: Published conference proceedings (MDPI)

Candidate involvement: First author and presenter of findings at the Nutrition Society of New Zealand's (NSNZ) annual symposium.

Purpose for inclusion: These proceedings are a result of the Candidate being accepted to present his research findings at the Nutrition Society of New Zealand's (NSNZ) annual symposium. The Candidate was awarded 'best oral presentation' at the symposium.

proceedings

Abstract

Can Leveraging Agrobiodiverse Food Systems Help Reverse the Rise of Malnutrition in Pacific Small Island Developing States (PSIDS)? †

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Published: 13 December 2019

Objective: Indigenous food systems of Melanesia contain vast genetic, biological and culture diversity. However, globalization is fuelling a nutrition transition away from traditional foods in favour of ultra-processed foods, leading to rises in non-communicable diseases. This research aimed to examine the sustainability of a rural food system on Rendova Island in Solomon Islands, and understand how the nutrition transition is influencing micronutrient intakes among rural Solomon Islanders.

Methods: Qualitative participatory focus group discussions (n = 86) captured food system transitions, challenges, and future projections. Quantitative household nutrition questionnaires (n = 30) measured usual nutrient intakes, diet diversity, and food sourcing patterns by using repeat multiple-pass 24 h recalls. The survey also assessed nutrition-related knowledge attitudes and practices (KAP), household food insecurity levels (FAO-FIES), and anthropometric data.

Results: Focus group participants identified 253 varieties of homegrown and wild foods (species and varieties) available in Baniata, including roots, tubers, bananas, fruits, vegetables, beans, nuts, seeds, eggs, livestock, and seafood. However, all focus group participants agreed that traditional knowledge and utilization of local agri-biodiversity is rapidly declining. Anthropometric data showed that 60% of participants were overweight or obese, with the average body fat percentage was 31% (n = 30). Diet patterns were increasingly reliant on ultra-processed imported foods such as white rice, biscuits, noodles, and sugary drinks. Usual dietary intakes were low in protein (53.3% below EAR), vitamin A (80%), iron (30%), calcium (96%), and thiamine (86%). Participants who consumed a higher ratio of homegrown and wild foods had significantly improved micronutrient intakes.

Conclusions: Local food knowledge and utilization is rapidly declining. Leveraging the power of nutrient-dense, biodiverse foods can help mitigate rising malnutrition. Improved understanding of neglected and underutilized (NUS) species could enhance nutrition-sensitive agriculture interventions aimed towards combating the rise of malnutrition and food security.

Appendix D: Ngali nut (*Canarium indicum* L.*)* Nutrient Analysis

Title: Ngali nut (*Canarium indicum* L.*)* mineral analysis

Status: Mineral composition analysis complete. Data to be submitted to a food composition journal.

Candidate involvement: Conducted atomic absorption analysis for specific trace minerals on ngali nuts from Solomon Islands and Papua New Guinea.

Purpose for inclusion: Ngali nuts are amongst the oldest and most important tree crops in Melanesia, and is an integral part of one of the world's first known permanent agroforestry systems. The nuts are often harvested from the wild and/or planted around villages and settlements. The nuts are sold locally, regionally, and increasingly to international markets.

Ngali nuts

Common Names: Ngali nuts, Java Almonds, Canarium nut, Galip nut, Kenari nut

Scientific name: *Canarium indicum* L.

Family: Burseraceae

Geographical spread: Eastern Indonesia, Papua, New Guinea, Solomon Islands, and Vanuatu.

Overview

Ngali nuts (*Canarium indicum* L.) are a culturally and ecologically significant food across much of Melanesia. Ngali nuts are produced from large evergreen trees that can reach 25 m tall (Figure D.1). These trees have been traditionally used within agroforestry systems across much of Melanesia (Leakey et al., 2008). The nuts drop from the tree and are harvested by the community (primarily women) as a communal activity. The nuts are then either eaten raw or baked in a traditional stone oven where they can be stored for long periods of time. Ngali nuts are often consumed locally as a key ingredient in a variety of traditional recipes. Masi Masi is a traditional Solomon Island dish (Figure D.2) which combines baked ngali nuts with one of the most nutrient-dense vegetables in the Pacific, slippery cabbage (*Abelmoschus manihot*). Increasingly, Ngali nuts are being sold as an export agri-food crop regionally, nationally, and internationally, which provides a sustainable source of income for rural Indigenous peoples. (Nevenimo et al., 2007). More information on the Ngali nut can be found in Chapter 5.

Figure D1: Ngali nut tree mixed with agroforestry (left); Ngali nuts with outer shell intact (top right); Ngali nuts cracked by hand using stones (bottom right).

Photos by Chris Vogliano

Figure D2: Traditional Masi Masi dish made by layering slippery cabbage and ngali nuts together.

Photo taken by Chris Vogliano in the Solomon Island village of Baniata in the Western Province.

Ngali nut trace element mineral analysis

To the candidate's knowledge, ngali nuts have energy, macronutrient, and micronutrient composition conducted, but a comprehensive trace mineral and heavy metal analysis has not previously been conducted. With the support of Dr. Nick Kim from Massey University (Wellington), the candidate was able to use a ContrAA 700 Atomic Adsorption Spectrophotometer (AAS) to conduct trace mineral analysis on samples of Ngali nuts from both Solomon Islands and Papua New Guinea. The ContrAA spectrophotometer enables sequential analyses of chemical elements employing the absorption of optical radiation by free atoms in the gaseous state; in order.to determine the concentration of a particular element in an analyzed sample. Trace elements analyzed by the Candidate were zinc, copper, iron, and manganese. To confirm the Candidate's findings, samples from the same source were sent to Hill Laboratories (accredited by International Accreditation New Zealand). Hill Laboratories conducted a complete trace mineral analysis (data included below). Data were combined with a previous nutrition analysis conducted by Eurofins and the Pacific Islands Food Composition Tables (2nd Edition) (Dignan et al., 2004) to compile the first comprehensive nutrient and mineral profile of Ngali Nuts (Table D.1). Ngali nuts were dry roasted (without oil) with traditional stone ovens or raw, as indicated in the 'Form' column below.

Table D1: Comprehensive nutrient profile of Ngali Nuts per 100g (*Canarium indicum* L.)

Nutrient	Unit	Quant (per 100g)	Lab	Form
Energy	*kJ*	2910	Eurofins	Dry Roasted
Protein	*g*	14.1	Eurofins	Dry Roasted
Fat	*g*	68.4	Eurofins	Dry Roasted
Saturated fat	*g*	31.6	Eurofins	Dry Roasted
Monounsaturated fat	*g*	30.4	Eurofins	Dry Roasted
Polyunsaturated fat	*g*	6.3	Eurofins	Dry Roasted
Alpha linolenic acid	*g*	0	Eurofins	Dry Roasted
Linoleic Acid	*g*	6	Eurofins	Dry Roasted
Cholesterol	*mg*	0	Eurofins	Dry Roasted
Carbohydrate, available	*g*	3.1	Eurofins	Dry Roasted
Sugars	*g*	2.1	Eurofins	Dry Roasted
Dietary fibre	*g*	9.9	Eurofins	Dry Roasted
Sodium	*mg*	14	Eurofins	Dry Roasted
Potassium	*mg*	627	Eurofins	Dry Roasted
Retinol	*mg*	0	PIFC2	Raw
B-carotene equiv.	*mg*	165	PIFC2	Raw
Thiamin (B1)	*mg*	0.13	PIFC2	Raw
Riboflavin (B2)	*mg*	0.06	Eurofins	Dry Roasted
Niacin	*mg*	1.7	PIFC2	Raw
Vitamin B12	*mg*	0	PIFC2	Raw
Vitamin C	*mg*	8	PIFC2	Raw
Trace minerals				
Calcium	*g/100g*	0.033	Hill Labs	Dry Roasted
Magnesium	*g/100g*	0.411	Hill Labs	Dry Roasted
Potassium	*g/100g*	0.818	Hill Labs	Dry Roasted
Sodium	*g/100g*	<.005	Hill Labs	Dry Roasted
Iron	*µg/100g*	31.57	Massey/Hill	Dry Roasted
Aluminium	*µg/100g*	2.375	Hill Labs	Dry Roasted
Antimony	*µg/100g*	< 0.10	Hill Labs	Dry Roasted
Arsenic	*µg/100g*	< 0.10	Hill Labs	Dry Roasted
Cadmium	*µg/100g*	0.0252	Hill Labs	Dry Roasted
Cesium	*µg/100g*	< 0.010	Hill Labs	Dry Roasted
Chromium	*µg/100g*	< 0.06	Hill Labs	Dry Roasted
Cobalt	*µg/100g*	0.138	Hill Labs	Dry Roasted
Copper	*µg/100g*	13.9	Massey/Hill	Dry Roasted

Lead	*μg/100g*	< 0.010	Hill Labs	Dry Roasted
Lithium	*μg/100g*	< 0.10	Hill Labs	Dry Roasted
Manganese	*μg/100g*	32.71	Massey/Hill	Dry Roasted
Mercury	*μg/100g*	< 0.010	Hill Labs	Dry Roasted
Molybdenum	*μg/100g*	0.472	Hill Labs	Dry Roasted
Nickel	*μg/100g*	0.13	Hill Labs	Dry Roasted
Rubidium	*μg/100g*	15.64	Hill Labs	Dry Roasted
Strontium	*μg/100g*	3.85	Hill Labs	Dry Roasted
Thallium	*μg/100g*	< 0.005	Hill Labs	Dry Roasted
Tin	*μg/100g*	< 0.10	Hill Labs	Dry Roasted
Uranium	*μg/100g*	0.002	Hill Labs	Dry Roasted
Vanadium	*μg/100g*	< 0.05	Hill Labs	Dry Roasted
Zinc	*μg/100g*	32.28	Massey/Hill	Dry Roasted
Bromine	*μg/100g*	< 1.0	Hill Labs	Dry Roasted
Iodine	*μg/100g*	0.081	Hill Labs	Dry Roasted
Selenium	*μg/100g*	0.027	Hill Labs	Dry Roasted
Amino Acids				
Aspartic Acid	*mg/kg*	13000	Eurofins	Dry Roasted
Serine	*mg/kg*	6900	Eurofins	Dry Roasted
Glutamic Acid	*mg/kg*	33000	Eurofins	Dry Roasted
Glycine	*mg/kg*	7050	Eurofins	Dry Roasted
Histidine	*mg/kg*	2800	Eurofins	Dry Roasted
Arginine	*mg/kg*	18500	Eurofins	Dry Roasted
Threonine	*mg/kg*	4250	Eurofins	Dry Roasted
Alanine	*mg/kg*	4100	Eurofins	Dry Roasted
Proline	*mg/kg*	5500	Eurofins	Dry Roasted
Tyrosine	*mg/kg*	3350	Eurofins	Dry Roasted
Valine	*mg/kg*	6250	Eurofins	Dry Roasted
Lysine	*mg/kg*	4000	Eurofins	Dry Roasted
Isoleucine	*mg/kg*	4300	Eurofins	Dry Roasted
Leucine	*mg/kg*	10500	Eurofins	Dry Roasted
Phenylalanine	*mg/kg*	6750	Eurofins	Dry Roasted
Methionine	*mg/kg*	3100	Eurofins	Dry Roasted
Hydroxyproline	*mg/kg*	135	Eurofins	Dry Roasted
Taurine	*mg/kg*	<50	Eurofins	Dry Roasted

Application of knowledge

Ngali nuts are an energy-dense source of nutrition when compared to cashews and almonds, and are similar in energy density to macadamia nuts (Table D.2). After baking, ngali nuts are able to be stored for many months in sealed containers, which helps provide food and nutrition security for Indigenous Peoples during lean seasons or times of extreme weather events. Ngali nuts are a high-fat nut (68.4%) with a split ratio of saturated fats (31.6%) and monounsaturated fats (30.4%). Comparatively, ngali nuts have significantly more saturated fatty acids when compared to cashews, almonds, and macadamia nuts. The smoke point of ngali nuts is 216°C, slightly higher than olive oil (210°C), and slightly below almond oil (221°C). To our knowledge, this is the first analysis conducted on trace and heavy metals in ngali nuts, and our analysis found no evidence of heavy or toxic elements from Solomon Islands or Papua New Guinea. Therefore, these nuts are safe to consume and can be part of a healthy diet.

Table D2: Ngali nuts compared with cashews, almonds, and macadamia nuts (per 100g; dry roasted)

Nutrient	Unit /100g	Ngali Nut [1]	Cashews [2]	Almonds [2]	Macadamia nuts [2]
Energy	*kJ*	2910	2360	2430	3050
Protein	*g*	14.1	16.8	22.1	9.8
Fat	*g*	68.4	51.3	52.8	73.7
Saturated fat	*g*	31.6	8.7	4	11
Monounsaturated fat	*g*	30.4	32.5	33.7	58.2
Polyunsaturated fat	*g*	6.3	7.8	12.7	1.3
Alpha linolenic acid	*g*	0	0	0	0
Linoleic Acid	*g*	6	7.8	0	0
Cholesterol	*mg*	0	0	0	0
Carbohydrate, available	*g*	3.1	26.3	5.6	4.5
Sugars	*g*	2.1	6	4.9	3.8
Dietary fibre	*g*	9.9	4.3	11.8	9.3
Sodium	*mg*	14	16	1	5
Potassium	*mg*	627	660	96	370
Retinol	*mg*	0	1	0	0
B-carotene equiv.	*mg*	165	6	1	0
Thiamin (B1)	*mg*	0.13	0.49	0.07	0.35
Riboflavin (B2)	*mg*	0.06	0.22	0.86	0.11
Niacin	*mg*	1.7	7.4	0.13	3.8
Vitamin B12	*mg*	0	0	0	0
Vitamin C	*mg*	8	0	0	0
Trace minerals					
Calcium	*mg*	33.4	32	270	70
Iron	*mg*	3.15	6.3	4.5	1.8
Zinc	*μg*	32.29	5.3	0.5	1.7
Iodine	*μg*	0.08	11	0	9
Selenium	*μg*	0.03	40	2.8	7

[1] Eurofins / Hill Labs / Pacific Island Food Composition Tables (2nd edition)
[2] New Zealand Food Composition Tables 13th edition (2018)

Ngali Nut trees are ecological foundations of healthy agroforestry systems across Melanesia, and are culturally-important foods that help sustain rural communities. Ngali nuts have the potential to serve as an important source of nutrition, as well as an agri-food export to help sustain the livelihoods of rural Indigenous Solomon Islanders.

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Appendix E: Training manual for Solomon Island Nutritionist Enumerators

Training Manual for Nutrition Enumerators

24-hour dietary recall, nutrition questionnaire, and anthropometrics

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Project Overview

The Pacific Islands are uniquely at risk for climate-related hunger and nutrition security issues. Rising sea levels, ocean acidification, and increasingly extreme weather patterns are threatening the Solomon Island food system systems. The Convention on Biological Diversity, UNEP, The World Bank, and the Food and Agriculture Organization have all identified biodiversity as an essential element for sustainable development, citing it is at the centre of economic activities, food security, improved nutrition and genetic diversity.

Currently, 93.1% of Solomon Islanders consume less than five servings of fruit/vegetables a day, and 52.2% of adults living in Solomon Islands are overweight or obese.6 Scaling up biodiversity not only supplies adequate macronutrients, but also contributes significant essential micronutrients and phytonutrients that promote healthy lives and improve food security. Diets that have increased biodiversity also have higher levels of vital micronutrients, including vitamin A, iron, folate, and zinc.

Interventions aimed to improve health outcomes in developing countries often focus on single nutrient approaches. However, studies show that micronutrient deficiencies rarely occur in isolation. Diet diversification offers a reliable option for long-term sustainability of food resources in communities, particularly when traditional knowledge and sociocultural values are harnessed and utilized. Leveraging the power of traditional fruits and vegetables can be a part of the solution towards a more sustainable food system.

Solomon Islands are recognized as a "Centre of Plant Diversity", and are home to 4,500 different species of plants - 3,200 of which are Indigenous and at least 120 are edible. Preserving biodiversity is a chief goal of the Solomon Island government. There is an urgent need to improve food security through the promotion of sustainable food systems. Sustainable food systems can improve food and nutrition security through the inclusion of nutrient-dense traditional and biodiverse foods.

The data collected will contain qualitative and quantitative data to characterize traditional food systems, and assess food security levels, nutrient composition, and identify any food waste that occurs. Data collected from this research will inform local education initiatives and place-based policy recommendations.

Additionally, improved documentation of the food system and Indigenous knowledge can help preserve this important information for future use. The data collected from this project has the opportunity to not only improve the lives of rural Solomon Islanders, but also to influence the reshaping of the global food system.

Research Objectives

Characterize the Indigenous food system of the rural Solomon Island village of Baniata on Rendova Island and document local agrobiodiversity and food cultures and document changes over time

Document Indigenous food system resilience over time, especially to climate change

Asses nutrition and dietary intake and identify dietary gaps and food security of women

Identify the knowledge, attitudes, and practices (KAP) of nutrition and food waste

Research Questions

How has the local food system evolved and changed over time?

What are the biggest threat to the local food system sustainability and how are these threats being managed?

What is the food flow of the local food system on Rendova Island?

How is the food system changing with influence from outside cultures and globalization?

What role do local Indigenous and traditional foods have on the nutrient intake of Indigenous islanders?

What are the household food security levels of those living on Rendova Island?

Are significant amounts of food wasted being wasted? If so, how is it managed?

What, if any, are the barriers to eating a healthy and biodiverse diet?

What is the anthropometric data (BMI, body fat percentage) of the female head of household of reproductive age (15-50)?

Approach and confidentiality

The purpose of this study is not to judge, but to simply assess the current dietary patterns. It is extremely important to eliminate personal bias, nudging, or opinions when administering this survey. Do not assume portion sized or answers, but work with the participant to obtain the most accurate information possible. Any bias will likely influence the participant's responses and skew the data.

Ensure the participant that the information collected will be anonymized and treated respectfully. Do not allow unauthorized person(s) to see the interview data - even other family members. Do not discuss the information in the survey with anyone except the field supervisors (Jessica and Chris).

Above all, ensure the participant feels comfortable while participating in the survey. Initiate the conversation with small talk and local greetings.

Informed consent

Informed consent must be obtained through verbal communication at the beginning of the study. It is important to ensure the participant understands they are not required to participant, answer any specific questions, and can quit at any time. The informed consent sheet is the first page of the nutrition questionnaire. The study cannot begin without obtaining this consent.

Sampling

This study will follow a non-probability sampling scheme, which is a convenience sampling that involves interviewing participants who are available at the time of the study. The goal is to reach 4 households per interviewer per day.

50 households, interviewing the head of household

Snowball sampling will be utilized until the quota of participants is reached (50 households

Eligibility Criteria

Woman of reproductive age who is primarily responsible for food provisioning of household

Indigenous Solomon Islander

Reproductive age (15-50)

Non-pregnant and non-lactating

Part 1 | Informed consent and demographics

The first section of the interview will consist of verbal informed consent (page 1). Read this page out loud and ensure the participant agrees and is willing to participate. If they do, continue to page 2.

Page 2 contains sociodemographic questions of the participant. Questions 2-6 are qualifying questions, and if the participant does not meet the requirements of the study, then please thank them and stop the interview.

If at any time the participant responds with an answer that is not provided and there is no close answer, please write in the margin of the survey.

Part 2 | 24-hour dietary recall instructions

Introduction

The purpose of this 24-hour dietary recall is to assess the household's dietary intake over the 24 hours preceding the initiation of the dietary recall. This intake is assessed by measuring the intake of the person responsible for food preparation for the household. The participant of the survey will be asked about all foods eaten inside the home during the precious day and night by any member of the household.

Tools for estimating quantities of ingredients cooked or consumed

The tools below have been selected to improve the reliability and accuracy of the 24-hour dietary recall. To properly use the tool, conduct the interview in a quiet area with a flat surface, preferably near the kitchen if possible.

<u>If there is any confusion as to how to utilize these tools, please don't hesitate to ask for clarification.</u>

Data sheets

The primary tool of this study will include the data sheets for each respondent. These can be found in the nutrition questionnaire. These sheets will be used to document the food eaten, species, quantity, time of day, and cooking method. It is important to be as accurate as possible while not assuming or nudging the participant for responses.

Graduated cylinders

1000 mL (1), 500mL (1), and 100mL (1) cylinders are provided to help improve the accuracy of liquids and free flowing foods such as rice. You can use these tools to have the participant fill up their personal cup/bowl with the correct amount of liquid such as tea, soup, fizzy drink, etc. Then pour the drink into the graduated cylinder to measure the exact (mL) of the food.

For pots and bowls, woks, etc: pour water in the unit up to level of total cooked volume then measure by graduated cylinder. Record volume by mL.

Graduated cylinders can also be used with modelling clay or paper pieces to determine the quantity of food cooked or consumed. For more information see below.

Modelling Clay

Use the clay dough model and ask her to re-construct the same size of the ingredients used for cooking or eating

Fill measuring cylinder and note the level (a)

Place clay into cylinder and record new water level (b)

Volume of ingredient/food consumed is b-a (v= b-a)

Paper strips

Ask the respondent to show the size/quantity using strips of newspaper – particularly useful for bunches of vegetables. Once quantity is established, gently pour the paper in to the cylinder and record the volume.

Make sure not to scrunch, compress or change the density of the paper cuts compared to what the women prepared.

Once poured in the cylinder, if not level, you can gently tap the cylinder to try and level but do not press down on the paper

If there is too much paper for the cylinder, divide the amount of paper and measure in multiple amounts and add the total.

For plates, fry pan and other flat serving vessels: ask respondent to use the cut paper shreds to fill the plate to the amount it was filled with the food. Then gently place the paper into the gradual measuring cylinder, shaking and tapping to gently settle the paper. Record the volume.

Small food kitchen scales

These scales are used to measure the exact quantity of a food or meal eaten. If the respondent has the food and bowl/plate/cup used, tare the utensil and then add the estimated amount of food prepared/consumed. Record the weight in grams on the data sheet.

cm	centimeter	mmol	millimol (10^{-3} mol)
fl oz	fluid ounces	mg	milligram (10^{-3}g)
g	gram	ng	nanogram (10^{-9}g)
g	gravitational constant	nm	nanometer (10^{-9}m)
in	inch	pg	picogram (10^{-12}g)
kcal	kilocalorie	T	tablespoon
L	liter	t	teaspoon
lb	pound	µg	microgram (10^{-6}g)
MJ	megajoule (10^{6} joules)	µL	microliter ((10^{-6}g)
mL	milliliter (10^{-3}L)	µmol	micromole (10^{-6} mol)
mm	millimeter (10^{-3}m)	w/v	weight for volume

1t	= ⅓T	= ⅙fl oz	= 4.9mL
3t	= 1T	= ½fl oz	= 14.8mL
2T	= ⅛ cup	= 1fl oz	= 29.6mL
4T	= ¼ cup	= 2fl oz	= 59.1mL
5 ⅓T	= ⅓ cup	= 2 ⅔fl oz	= 78.9mL
8T	= ½ cup	= 4fl oz	= 118.3mL
10 ⅔T	= ⅔ cup	= 5 ⅓fl oz	= 157.7mL
12T	= ¾ cup	= 6fl oz	= 177.4mL
14T	= ⅞ cup	= 7fl oz	= 207.0mL
16T	= 1 cup	= 8fl oz	= 236.6mL
1mL	= 0.034fl oz	= 1cc	= 0.001 liter
1 liter	= 34fl oz	= 1000mL	

Note: The U.S. and Canadian standard measuring spoons used above are slightly smaller in capacity than the equivalent United Kingdom standard measuring spoons.

Conducting the interview[1]

Respondents are more likely to feel at ease if the interviewer observes local forms of greeting and personal address, and is dressed in a similar fashion to the respondents.

For the first pass of the recall interview, a list of all the foods and drinks (including drinking water) consumed during the preceding 24-hour period is obtained.

The interviewer should start by reestablishing a rapport with the respondent and follow this with a brief introduction about the purpose of the study, during which the name and identification of the interviewer should be given to the respondent.

Respondents should be reminded that questions will cover all the food and beverages, including snacks, consumed during the preceding day, with emphasis on the pattern of eating. Stress to respondents that all responses will be confidential, and emphasize the importance of providing the correct information.

Neutral questions should be used throughout the interview, such as “When did you get up in the morning?” and “Did you eat or drink anything then?” Avoid asking questions about specific meals (e.g., breakfast, lunch, or supper) or about snacks. Respondents should be given sufficient time to consider their responses and to clarify answers where necessary.

[1] *Adapted from FAO interactive 24-hour recall methodology*

During the interview, the interviewer should keep an open mind and avoid showing signs of surprise, approval, or disapproval of the respondent's eating pattern. The interview must always be con- ducted with an open and pleasant manner with the aim of being friendly, diplomatic, empathetic, and determined, as appropriate.

Four Step Procedure: Recalling the foods and drinks consumed

Taking Page 1 - List all foods and drinks consumed

Following instruction on page 1 of the questionnaire, ask about all foods (individual foods or dishes) and drinks consumed, in a free recall.

Record information on corresponding columns from column 1 to column 5 on the first page of the 24-hour recall

Once completed for a food/dish, ask "What was the next thing that you ate or drank?" Probe for water, snacks, alcohol, vitamin supplements or functional foods, and testing/tasting of foods during the cooking and preparation of the meals.

Review the list of foods and drinks consumed with the respondent, checking to see if anything is missing between entries. Ask them to confirm their order by eating time.

Add any additional foods or drinks to the bottom of the list (no need to squeeze it between already recorded entries) and complete the process.

For each mentioned food, ask what time of day it was eaten, if it was for a main meal or snack, and the place that each food was consumed.

Ask about the cooking method or form eaten of each individual food they ate in order, record on column 6.

Taking page 2 Ask about specific meal/food ingredients and recipes

Transcribe from page one IN ORDER of the time consumed and name of the first food/ dish/drink onto columns 1 & 2 of page 2.

On column 3 "Ingredient and description":

If the food/drink was a single food item like an apple (that is, not a mixed dish with a recipe), list its name on column 3.

For mixed dishes/ recipes, following are steps to ask for information of each ingredient in the dish:

Ask the respondent to tell you all the ingredients that were used to prepare that food/dish. List all ingredients using a free recall, one ingredient on a row.

Be sure to probe for condiments, fats, salt etc.

Review the ingredient name for that food on column 5 of the first page to ensure none are missing.

Probe to describe the details of the ingredient's part (pork belly with skin, chicken wing, sweet potato leaves, sweet potatoes tuber…), processing way (fresh, dried, smoked, partly cooked, salted…) and storage, ripeness status (green/immature, semi-ripe, or ripe) and variety or species.

Pay particular attention to asking about the color of the food and the specific variety of the ingredient (species, sub-species, type, cultivar, breed, wild…),

E.g. a sweet potato can be orange, white or purple.

Record the specific name associated with the variety of food (orange sweet potato) instead of generic name (sweet potato)

More examples are in Annex 1

Record all these descriptions next to the ingredient's name on column 3.

Add instructions for source of food/drink

If the mixed dish, ingredient of food or drink was purchased already processed (e.g. store bought cake, bread, cooking oil) ask.

ask what the brand is and record in column 3. If unknown record brand unknown.

Ask where they have sourced that specific ingredient, food item or drink and fill answer option with corresponding number on column 4.

For any ingredients that you are not familiar with and if it is not available for you to see, ask if they can find a picture of it in the food composition tables from Food Plant Solutions. If you cannot find it to see, note that point on column 12 and take a photo if possible.

Record what the name is and its description and the enumerator should raise it with the field supervisor at the end of the day and the supervisor can follow up to understand what the food is.

For mixed dishes ask the respondent to quantify the amount of each ingredient used to prepare and cook the dish, using the method appropriate for the type of food (annex 1). Record the answer in column 5.

Once all the ingredients are listed for a dish, ask the participant to describe the total quantity (volume) of food produced after cooking using methods listed in Annex 1. Record answer on column 6.

Ask the respondents to show the total amount cooked by demonstrating the total volume using the unit it was cooked or served in – whichever is more appropriate (pan, big bowl…). There are two key measuring methods that are most effective:

For pots and bowls, woks: pour water in the unit up to level of total cooked volume then measure by graduated cylinder. Record volume by mL.

For plates, fry pan and other flat serving vessels: ask respondent to use the cut paper shreds to fill the plate to the amount it was filled with the food. Then gently place the paper into the gradual measuring cylinder, shaking and tapping to gently settle the paper. Record the volume.

After complete information about all ingredients for each food, review the list of ingredients with the respondent then move to the next food or drink in the list.

TABLE 5.2

EXAMPLES OF PROBES TO OBTAIN DETAILED DESCRIPTIONS OF SPECIFIED FOODS

Food Type	Required Detailed Information
Meat	Kind of meat; description of cut, raw or cooked weight, method of cooking, lean or lean plus fat, bone in or not (waste factor)
Fish and seafood	Kind of fish or seafood; raw or cooked weight; method of cooking; amount of bones, skin, or shell (waste factor)
Poultry	Kind of poultry; parts or pieces eaten (e.g., breast, thigh), raw or cooked weight, method of cooking, white or dark meat, meat plus skin or meat only, bones (waste factor)
Fats	Kind of fat, brand name (if possible)
Milk products	Kind of dairy product, brand name (if commercial product), percentage fat (as butter fat or milk fat), liquid vs. powdered milk
Cheese	Kind of cheese (whole milk hard cheese, fresh cheese, Swiss, cream, etc.), percentage fat (if known), brand name (if commercial product)
Bread, rolls	Type of grain (rye, whole wheat, etc.), homemade or bought, size: standard or unusual, toasted or not, topping and condiments, brand name (if commercial product)
Baked goods	Type of product, whether iced or not, homemade or commercial, type of filling
Cereal, pasta, or rice	Type of grain, whole or refined, milled or polished (for rice), brand name, raw or cooked weight, enriched or not, cereal plus milk (if dry quantity unknown), method of cooking
Vegetables	Fresh, frozen, or canned; peeled or unpeeled; method of cooking; topping (butter, etc.)
Fruits	Fresh, stewed, frozen, or canned; peeled or unpeeled; type of liquid (heavy, light): sweetened or unsweetened; waste factor (e.g., peel, stone)
Beverages, soup	Fresh or frozen; canned or bottled; fruit juice: sweetened or unsweetened; added vitamins or minerals (e.g., vitamin C); coffee: brewed, instant, decaffeinated, regular; soups: homemade or canned, dilutant (milk or water), proportion of dilutant : concentrate (e.g., 1:1), recipe; brand name (if commercial product)
Street foods from vendors	Food (e.g., French fries and chips), brand name (if commercial product), condiments added, method of cooking, vendor's name/location
Mixed dishes	Product name, homemade or commercial, recipe ingredients, cooking method
Herbs, spices	Name; fresh or dried

Ask for the quantity of foods consumed:

Ask the respondent to quantify the food or drink consumed for each individual item or combined dish on the list.

For individual food items (e.g. apple, fried egg) ask the respondent to quantity the amount of food consumed and record directly in column 7 using the methods outlined in annex 1.

For mixed dishes, ask the respondent if they picked only certain pieces of the dish to eat OR if they ate equal portions (homogenous Vs non-homogenous)

If they ate equal portions (homogenous) – ask the respondent to quantify the total amount of the whole dish consumed (e.g. bowl of soup, porridge with minced pork; soup cooked with veggies and eggs).

If they only picked specific pieces out – ask the respondent to quantify the amount of each individual ingredient consumed from the dish (e.g. 5 pieces of meat, 2 pieces of onion). Record the amount consumed for each ingredient in column 7 and make the note 'non-homogenous' in the note column (8)

Ask to see the unit they use to eat or take the drink or food to eat (e.g. bowls, spoons, handfuls).

Ask how many units/ how much of that food that was consumed or how much they ate from the food taken. Determine if all of the food was eaten or if some food was left on the plate. Measure total consumed by graduated cylinder. Record on mL information on column 7.

Review the list of foods and drinks consumed with all details to ensure no missing.

Review and finish

Once the 24-hour food recall is complete read the list back to the respondent. Ask if the recall is correct or if they forgot to mention any food that was consumed.

TABLE 5.3

EXAMPLES OF METHODS THAT CAN BE USED TO ESTIMATE THE PORTION SIZES OF SELECTED FOOD TYPES CONSUMED

Food Type	Ways to Estimate Portion Size
Staple; boiled flour or roots, rice	Weigh equivalent amount of actual food *OR* salted replica of cooked food *OR* record weight or volume of clay replica *OR* use household measures (i.e., scoop, medium portion)
Roots and tubers or fresh maize, boiled or roasted*	Weigh equivalent amount of actual food either from household's store or from various sized roots and tubers that you carry (preferred method) *OR* measure length and circumference with a tape measure *OR* record as small, medium, or large
Porridges and soups	Measure equivalent volume in subject's own cup or bowl and weigh *OR* use household measures (e.g., cup or bowl)
Stews	Weigh equivalent amount of actual food *OR* salted food replica *OR* use household measures (i.e., cup, scoop, or medium portion)
Purchased foods (e.g., cakes and biscuits)	Record monetary value *OR* use household measures (e.g., cup, bowl, or piece)
Bread	Weigh actual food from supply that you carry (preferred method) *OR* measure length and thickness with a tape measure *OR* record as thin, medium, or thick slice
Fruits*	Weigh equivalent amount of actual fruit from household's store or from various sized fruits that you carry (preferred method) *OR* measure length and circumference with a tape measure *OR* record as small, medium, or large
Ground nuts*	Weigh equivalent amount of actual nuts from household's store or from those that you carry (preferred method) *OR* record monetary value *OR* record volume by using household measures (e.g., cup or bowl)
Meat or fish	Measure volume of clay model of equivalent size and shape *OR* measure length, width, and thickness with a tape measure *OR* buy and weigh a piece of equivalent size and shape (e.g., a chicken drumstick)

* Note that weights may need to be adjusted for inedible amounts (e.g., cobs, peel).

Species level information

It is important to record the different species and breeds and varieties because these can have different micronutrient compositions and can be the difference between a diet that is adequate in micronutrients or not. It will also be important to understand the role of local biodiversity in the diet.

If the specific variety or breed of the food is not known, try to get the common name and if possible take a picture if they still have the food available at home. At a last case, ask them to describe the characteristics of the specific species or variety, so that the research team can identify the species or variety, after data collection with an expert.

To better understand the biodiversity of diets, it is important to record the specific species, variety of the foods that are consumed. Species refers to the food type (e.g. apple, pork, banana, sweet potato). For example, it is not sufficient to record 'vegetable' or 'herbs' but we need to know what specific vegetable or herb. (See table 1)

Table 1

Food type/group	Examples of different species
Cereals	Bran, oats, rice
Roots and tubers	Taro, potato, sweet potato
Vegetables	Cabbage, green vegetables, mushroom
Fruit	Pineapple, banana, orange
Meat	Pig, beef, chicken
Fish	Squid, Salmon, red tuna, sardine

The variety refers to the type of the species, and goes into more details (e.g. red apple, black pork, wild pork, small yellow banana inside, orange sweet potato, white sweet potato).

Table 2

Food type/group	Examples of level of information needed to identify different breeds, variety
Cereals	White rice, coastal rice, highlands rice
Roots and tubers	Giant taro, Chinese taro, swamp taro, cassava
Vegetables	Chinese cabbage, swamp cabbage, cassava leaves, sweet fern
Fruit	Sweet banana, golden apple, pacific lychee
Meat	Wild pig (Hog), Kobe beef, canned spam, lamb mutton, turkey tail
Fish	Mahi Mahi, mackerel, spot bass, striped tuna

Part 3 | Food security and nutrition questionnaire instructions

The nutrition questionnaire should directly follow the 24-hour dietary recall. Please follow the instructions directly on the questionnaire form. Certain questions indicate that the interviewer should prompt the participant with answers, while others do not.

It is important to read the questions as is without judgement or bias. If the participant is unsure or does not want to answer, simply mark that as an option and move to the next question.

Examples of various questions:

Can you tell me some reasons why people may be overweight or obese? *Do not read aloud. Record all answers*	Too much food eaten -- 1 High fat and/or processed foods – 2 High sugar foods (sugar fizzy drinks) – 3 Low movement (physical activity) – 4 Not enough fruits and vegetables - 5 Don't Know or other (not relevant) – 98 Refused - 99
What are some nutrition benefits that are associated with eating beans (legumes)? *(write all mentioned answers)*	1. 2. 3.
What do you do with the food you grow / collect other than feed it to your family? ** Read out loud and mark all that apply*	Sell (formal) market - 1 Sell (informal) market – 2 Sell to neighbors – 3 Trade with neighbors - 4 Other - 5 Don't Know – 98 Refused - 99

Part 4 | Anthropometric measurement instructions

The purpose of this section is to take the height, weight, and body fat percentage of the participant. The body scale provided automatically calculates the body fat percentage once the user data is imported into the scale.

Be sure not to make any comments about the participant's height, weight, or body fat percentage at this time.

Start by measuring the participant using the measuring tape. Ensure the participant is standing on flat ground, and removes their shoes. Have them stand with their back against a straight wall and measure from the ground up.

The next step is to measure the participant's body weight and body fat using the bioelectric impedance scale. Start by placing the body weight scale on a flat surface. Have participant stand on the scale and record the weight. The scale will also report the bioelectric impedance. Be sure to record both numbers.

Anthropometrics	Measurement
Participants Height (cm – nearest .1)	__
Participants Weight (kg – nearest .1)	__
Body Fat Percentage	__

Appendix F: Nutrition Survey for Solomon Islands Research

Enumerator Name	
Date and Time	
Village Name	
Household Number	#
Participant Number	#

Informed consent and confidentiality of interviews for Adults

Good morning/afternoon,

We are from Massey University and Bioversity International, a nonprofit research organization that is assessing food systems, and nutrition within your village. We are working on a project examining food and nutrition, which you could participate. The interview will take about 1 hour to complete. All the information we obtain will remain strictly confidential and your answers and name will never be revealed. You are not required to answer any question you do not want to, and you may stop the interview at any time. This data ***may*** be used in a global data, but it will not identify you or your family.

The objective of this study is to assess the dietary practices of households in your community. Please do not feel pressured to give a specific response, and do not feel shy if you do not know the answer to a question. Feel free to answer questions at your own pace.

Do you agree to participate in this interview?

Yes ___ No ___ *If yes, continue to the next question; if no, stop the interview.*

Thank you. I am now going to share an overview of the research with you

1. To begin, we will discuss some basic questions about you and your household to see if you're eligible to participate in this research study.
2. If you are eligible, then we will review the food you prepared and ate over the last 24 hours. This will take around 20-30 minutes.
3. After this, we will go over some nutrition and food questions. This should last about 20 minutes.

Do you have any question before we start? (*Answer questions*).

Gudfala mone/aftanun.

Mifala from Bioversity intanasionol, wan fala grup, wea laek fo faendim hao na way blo kaikai an hao na hem helpm bodi blo pipol lo ples. Mifala waka lo onefala project fo faend aot abaot kakai an nutrison wea hem na iu save joen. Mi bae askem samfala questen an bae hem tek wanfala aoa. Everi toktok iu talem bae mifala no searem an bae mifala no talem nem blo iu tu. Sapos iu no laek ansa eni questen hem ok sapos iu laek fo stop hem ok tu.

Mein tingting behaen disfala stadi o saevi hem fo faend aot wei lo saed lo kaikai lo insaed haos lo community blo iu. Iu no wari fo givim raet ansa o sem sapos iu no save lo ansa.

Waswe, iu laek fo joen lo disfala stadi?

Tagio tumas. Distaem bae mi talem wat na mein tingting behaen disfala stadi.

U garem eni qesten bifo intala stat

Mi save stat nao?

NUTRITION SURVEY | Primary Female Cook of Household

Must be female, non-pregnant or lactating, and between 18-50 years of age

Demographics	Question	Respondent Answer
1. Name and code	What is your name? *Wat na nem blong iu?*	
	Insert participant code	_ _ _ _
2. Gender	Enter the gender of the respondent	Male **(stop)** □ Female □
3. Household cook	Are you responsible for preparing most of the food for your household? *iu nao, iu save mekem kaikai fo evri wan insaed lo haus blong iufala?* *If no, stop survey. Find the person who is primarily responsible for preparing the food.*	No (**stop**) □ Yes □
4. Pregnant or Breastfeeding	Are you currently pregnant or breastfeeding (lactating)? *iu babule o susum baby distaem?* *If yes, stop survey. A non-pregnant and non-lactating household cook must complete survey.*	Yes (**stop**) □ No □
5. Feast day	Did your diet yesterday vary dramatically from a normal day (i.e. was it a feast day)? *Kaikai blong iu yestade hemi difren from evri de o semsem? (e.g party)* *If yes, stop the survey and ask if you can come back another day.*	Yes (**stop**) □ No □
6. Age	How old are you? *What na age blong iu?* ***If participant is under 18 or over 50, stop the survey.***	Age in completed years ________
7. Household	How many people currently live in your household? *Hao meni fala pipol na iufala stap insaed wan fala haus?*	Number of people ________

8. Household members	What are the genders and ages of your household members? (List gender and age. *Names not needed.)* **Ex: M, 24; F 12**	
9. Educational level	What is the highest level of school you attended or qualification received? *iu skul kasim wat form o wat pepa nao iu tekem long skul?*	None □ Primary school □ Secondary school □ Higher □ Grade/Qualification _ _
10. Income source	What is your primary source of income? *Wat nao iufala long haus save tekem seleni lo hem?*	Farming (selling) □ Fishing □ Selling non-food items □ Community support □ Other ______________
11. Income	What is your household's average monthly income (SBD)?	$____________(SBD)
12. History of disease	Have you or anyone in your family been diagnosed with a chronic disease? *(EX: diabetes, heart disease, high blood pressure, or stroke?)*	None □ Diabetes □ Heart Disease □ Stroke □ Cancer □ Heart Disease □

24-hour dietary recall

BE SURE YOU'VE COMPLETED THE DQ-Q prior to starting this 24-hour recall

The next part of the questionnaire will assess the participant's dietary intake over the last 24 hours. For a detailed analysis of how to conduct this portion of the procedure, please review the training guide.

Species specific 24-hour dietary recall form <u>(FIRST DAY)</u>

Interviewer: Date:	Subject name: Subject ID:

1	2	3	4	5	6
Order	**Time**	**Meal type** 1 = breakfast 2 = lunch 3 = dinner 4 = snack	**Place eaten** 1 = home 2 = away	**Name of food / dish / drink**	**Cook method / form eaten**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					

PAGE 1

1	2	3	4	5	6	7	8
Order	**Food / Drink / Dish**	**Ingredient** Include variety / cultivar / breed / name of wild food ingredient	**Source** 1 = own production 2 = produce market 3 = supermarket 4 =street vendor 5 = friend/gift	**Quantity of <u>ingredient</u>** (g or mL)	**Total cooked of <u>dish</u>** (mL)	**Amount participant <u>consumed</u>**	**Notes**

PAGE 2

1	2	3	4	5	6	7	8
Order	**Food / Drink / Dish**	**Ingredient** Include variety / cultivar / breed / name of wild food ingredient	**Source** 1=own production 2=neighbor 3= supermarket 4=corner store 5= formal wet market 6=street market/vendor	**Quantity of ingredient** (g or mL)	**Total cooked of dish** (mL)	**Amount participant consumed**	**Notes**

PAGE 3

Don't forget to probe at end of recall

Probe for:

- **Alcohol?** □ _________________
- **Added sugar?** □ _________________
- **Added salt?** □ _________________
- **Iodized salt?** Yes □ No □ _________________
- **Supplements?** Iron □ Vitamins □ Vitamin A □ Other supplements □ _____________

Part 3 | Food Security Questionnaire

Quantitative Household Food Insecurity Experience Scale (FIES-SM, FAO)	Code	Answer
1. **In the last 12 months**, was there a time you or others in your household worried about not having enough food to eat because of a lack of money or other resources? *luk baek long las 12 manis, waswe, eni taem iu o eniwan long haus blong ufala wari tu, dat iufala no garem staka kaikai fo kaikaim becos iufala no garem selen o samfala reososes?*	No – 0 Yes - 1 Don't Know – 98 Refused – 99	_ _
1A. If yes, in the last 12 months, which months did you not have enough food to feed your family? (mark all that apply) *If iu talem yes, den, wat manis nao osem kaikai hem no staka fo fidim family blong iu?*	January □ February □ March □ April □ May □ June □ July □ August □ September □ October □ November □ December □ None □ Unsure □	
2. Still thinking about the last 12 MONTHS, was there a time when you or others in your household were unable to eat healthy and nutritious food because of a lack of money or other resources? *luk go baek long las 12 manis, waswe, eni taem iu tingim wea famili no kakaim helti kaikai becos iufala no garem selen o samfala resoses?*	No – 0 Yes - 1 Don't Know – 98 Refused - 99	_ _
3. In the last 12 months, was there a time when you or others in your household ate only a few kinds of foods because of a lack of money or other resources? *Long las 12 manis, waswe, eni taem iu tingim wea famili kakai lelebet kaikai nomoa becos iufala no garem selen o samfala resoses?*	No – 0 Yes - 1 Don't Know – 98 Refused - 99	_ _
4. In the last 12 months, was there a time when you or others in your household had to skip a meal because there was not enough money or other resources to get food? *long las 12 manis, waswe, eni taem iu o olketa pipol long haus blong iu misim eni taem fo kaikai tu, becos iufala no garem staka selen o samfala resosis fo baem kaikai?*	No – 0 Yes - 1 Don't Know – 98 Refused - 99	_ _

5. Still thinking about the last 12 months, was there a time when you or others in your household ate less than you thought you should because of a lack of money or other resources? *Luk go back long las 12 manis, waswe, eni taem iu o olketa pipol long haus blong iu kaikaim smol kaikai no fitim fo iu ful up tu, becos iufala no garem selen o samfala resosis?*	No – 0 Yes - 1 Don't Know – 98 Refused - 99	_ _
6. Was there a time in the last 12 months when your household ran out of food because of a lack of money or other resources? *luk go baek long las 12 manis, waswe, eni taem iufala long haus blong iu no garem eni kaikai tu, becos ufala no garem eni selen o samfala resosis?*	No – 0 Yes - 1 Don't Know – 98 Refused - 99	_ _
7. Was there a time when you or others in your household in the last 12 months were hungry but did not eat because there was not enough money or other resources for food? *long las 12 manis, waswe, eni taem iu o olketa pipol lo haus blong iufala hungere bat nating kaikai, becos iufala no garem staka selen o samfala resosis fo baem kaikai?*	No – 0 Yes - 1 Don't Know – 98 Refused - 99	_ _
8. Was there a time in the last 12 months when you or others in your household went without eating for a whole day because of a lack of money or other resources? *long las 12 manis, waswe, eni taem iu o olketa pipol long haus blong iufala no kaikaim eni kaikai fo ful dei, becos ufala no garem selen o samfala resosis?*	No – 0 Yes - 1 Don't Know – 98 Refused - 99	_ _

PART 4 I Nutrition Questionnaire

Enumerators: Please only read answers (code) aloud when indicated

Nutrition: Knowledge	Answer
1. Can you name 2 health problems that can occur when a person is overweight or obese? *Iu save givim nem blong eni 2 fala siki wea save kasim man taem hem ova weight o obese?*	1. 2.
2. Can you tell me some reasons why people may be overweight or obese? *Iu save talem why nao olketa pipol save overweight o obese?*	1. 2.

3. Can you name 2 foods that are good sources of Vitamin A? *Iu save givim nem blong 2 fala kaikai wea garem staka vitamin A?*	1. 2.		
4. Can you name 2 foods that are high in saturated (bad) fats? *Iu save givim nem blong 3 fala kaikai hem garem staka gris?*	1. 2.		
Nutrition: Attitudes **Read question, options, and then circle participant's answer.** **How much do you agree with these statements**	**Disagree**	**Neutral**	**Agree**
1. I am satisfied with the food choices I have when preparing household meals. *Me satisfy wetem olketa kaikai me siusim an wakem for everi wan lo haus fo kaikaim*	1	2	3
2. I feel it is **expensive** to purchase fruits and vegetables for my family. *Me feel osem hem expensive tumas fo baem oketa fruts an vegetables fo famili*	1	2	3
3. Imported foods from other countries are preferred foods for me and my family.	1	2	3
4. It is important to prepare a **wide variety** of foods for my family to consume *Hem impotent tumas fo me mekem different kaen kaikai fo famili kaikaim*	1	2	3
5. It is important to provide many **vegetables** for my family. *Hem impotant tumas fo mekem staka vegetable fo famili blong me*	1	2	3
6. It is important to provide many **fruits** for my family. *Hem impotant tumas fo mekem staka fruits fo famili blong me*	1	2	3
7. It is important to provide many **meats** for my family. *Hem impotant tumas fo mekem staka mit fo famili blong me*	1	2	3
8. It is important to provide many **fish** for my family. *Hem impotant tumas fo mekem staka fish fo famili blong me*	1	2	3
9. It is difficult to get my children to eat fruits and vegetables.	1	2	3

Me faendem hem hard tumas fo mekem olketa pikinini blo me fo kaikai fruits an vegetables			

Nutrition: Practice		**Answer**
1. What (if any) are the main challenges to eating a healthy diet? *[do not read answers]* *Wat nao samfala challenge (problem) hem stopem iu from kaikai healthy diet wea iu facim?*	Health foods not available - 1 Lack of money to buy – 2 Lack of time to prepare – 3 Do not know how to prepare – 4 Family does not like the foods – 5 No challenges - 6 Don't Know – 98 Refused - 99	
2. How often do you smoke cigarettes? *iu smok cigarette? Hao many taems?*	Daily – 1 Weekly – 2 Monthly – 3 **Never** / not frequently - 4 Don't know/ refused - 99	
3. How often do you use betel nut? *Hao many taems nao iu save kaikai belnut?*	Daily – 1 Weekly – 2 Monthly – 3 **Never** / not frequently - 4 Don't know/ refused - 99	
4. How often do you consume fizzy drinks? *Hao many swit drink nao iu save drinkim long wan fal dei?*	Daily – 1 Weekly – 2 Monthly – 3 **Never** / not frequently - 4 Don't know/ refused - 99	
5. If available, how often do you read nutrition facts on the labels of packaged foods? *Iu save riddim tu nutrition writing olketa save writim long plastic blong kaikai long store?*	Never – 1 Sometimes – 2 Always - 3 Don't Know – 98 Refused - 99	

Food Waste Questions	**Code**	**Answer**
1. Does your household use any food preservation methods? If yes, which ones? *Iu fala long haus usim eni technique fo kipim kaikai fo hem no nogut?* *** Read options out loud and mark all that apply**	Refrigeration - 1 Drying - 2 Making flour - 3 Smoking – 4 Pickling, fermenting, or canning – 5 None used - 6 Don't Know / other – 98 Refused - 99	

2. Once food enters your home, does your household ever waste any? (i.e.: does any of your food ever spoil before your household can eat it?) *Waswe, iufala long haus save spoilem kaikai tu? (osem eni left ova iufala no kakaim den torowe nomoa)* *Ex: fruit rotting, leftovers not eaten in time, fish spoiling, etc.* ***If no, skip to part 4***	Yes – 1 No – 2 Don't Know – 98 Refused - 99	
1. If yes, what percentage of food (out of 100%) do you feel your household wastes? *Hao many percentage long kaikai nao iu feel osem iufala save spoilem?*	_____ %	
2. What are the main reasons the food is wasted? *Wat nao samfala rison wea kaikai save nogut an west lo hem?* *** Read out loud and mark all that apply**	Lack of storage facilities - 1 Too much grown– 2 Too much collected - 3 Can't sell/trade it all – 4 Goes bad before use or reuse – 5 Lack of refrigeration – 6 Cooked too much food - 7 Forget or don't want to use it - 8 Don't Know / other (record) – 98 Refused - 99	
3. What foods tend to be wasted most often? *Wat kaen kaikai nao iu tingim hem save west tumas?* *** Read out loud and mark all that apply**	Vegetables – 1 Fruits – 2 Fish – 3 Meat – 4 Staple foods (starch) – 5 Nuts and seeds – 6 Dairy and eggs - 7 Drinks – 8 Don't Know / other – 98 Refused - 99	
4. Where does this food waste end up? *wea nao kaikai hem save west ya iufala save torowen?* *** Read out loud and mark all that apply**	Discard with trash - 1 Feed animals - 2 Compost for garden – 3 Don't Know / other – 98 Refused - 99	
Agriculture & Farming Questions	**Code**	**Answer**

1. What is the main reason you grow the crops you do? (choose top reason)	Market sale - 1 Nutrition/Health - 2 Taste/preference - 3 Climate change / adaptability - 4 Traditional food/culture - 5 Don't Know / other (<u>record</u>) – 98 NA - 99	
2. What percentage of crops you grow (out of 100%) are for: **A. Household consumption?** **B. Barter (community)?** C. **Market Sale?**	A. Household ________________% B. Barter ________________% C. Market sale? ________________%	
3. Do you use any fertilizers, pesticides, herbicides, or fungicides?	Fertilizers □ Pesticides □ Herbicides □ Fungicides □ None □ Not sure □	
3A: If yes, which do you use?	Free list top used fertilizers, pesticides, herbicides, or fungicides:	

FARM DIVERSITY

Can you please name all **species and varieties** of food (plants and animals) that you are **<u>currently available for harvest/consumption</u>** on **<u>your</u>** farm.

Species **(ie: yam, chicken)**	**Variety** **(ie: yellow, featherless neck)**	**How many did you produce?** **1 = not very much, few** **2 = a medium amount** **3 = a large amount**	**Has this increased, stayed the same, or decreased from previous years?**	**For personal use, market, or both?**
Step 1		**Step 2**		
<u>EXAMPLE:</u> YAM	PURPLE COLOUR	3	↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B

			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
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			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B

WILD FOODS: Are there any **wild foods** you do not grow, but are **currently available** (in season now) for **collection** from the **wild**?

Species (ie: fern)	Variety (ie:)	How often do you collect these foods? 1 = not very much, few 2 = a medium amount 3 = a large amount	Has this increased, stayed the same, or decreased from previous years?	For personal use, market, or both?
<u>EXAMPLE:</u> FERN	AFOGO	1	↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B
			↑ ↓ ↔	P - M - B

Appendix G: Research Approval Documents

Research approval from Massey and Solomon Islands Government related to research

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Date: 30 May 2018

Dear Chris Vogliano

Re: Ethics Notification - **4000019609 - Characterization and Assessment of Indigenous Food Systems to Strengthen Local Capacities and Inform Global Debates on Sustainability**

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 Professor Craig Johnson, Director - Ethics, telephone 06 3569099 ext 85271, 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

Solomon Islands Government
Ministry of Education and Human Resources Development
P O Box G 28
Honiara, Solomon Islands

Ph: (677) 24664
Fax: (677) 22042

Our Ref: 10/18

Date: 28th /06/2018

In Accordance to the Research Act 1982 (No. 9 of 1982) RESEARCH PERMIT:

Permission is hereby given to:

1. Name (s): Shane Tutua
2. Country: Solomon Islands
3. Research subject areas: The study is to explore and assess the indigenous Food Nutrition in Solomon Islands
4. Ward (s): Rendova
5. Provinces: Western Province
6. Conditions:

   a. To undertake research only in subject areas specified in 3 above.
   b. To undertake research only in the ward (s) and Province (s) specified in 4 and 5 above.
   c. To observe with respect at all times local customs and the way of life of people in the area in which the research is carried out.
   d. Not to take part at any time in any political or missionary activities or local disputes.
   e. To leave four (4) copies of your final research report in English with the Solomon islands Government Ministry responsible for research at your own expense.
   f. A research fee of SBD500.00 must be paid in full or the Research Permit will be cancelled. (See sec. 3 subject 7 of the Research Act).
   g. This permit is valid until **30 December 2018** provided all conditions are adhered to.
   h. No live species of plants and animals to be taken out of the country without approval from relevant authorities.
   i. A failure to observe the above conditions will result in automatic cancellation of this permit and the forfeit of your deposit.

MINISTER
MINISTRY OF EDUCATION, HUMAN RESOURCES & DEVELOPMENT

Signed: ....
Minister of Education and Human Resources Development

Date: 5 July 2018

Research approval from Massey and Solomon Islands Government related to research

MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA
UNIVERSITY OF NEW ZEALAND

Date: 29 April 2019

Dear Chris Vogliano

Re: Ethics Notification - **4000020954** - **Assessing sustainable diets in three geographically distinct indigenous Solomon Island populations**

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 Professor Craig Johnson, Director - Ethics, telephone 06 3569099 ext 85271, 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

SOLOMON ISLANDS NATIONAL UNIVERSITY

Solomon Islands National University
Office of Research and Postgraduate Studies

P O Box R113, Honiara, Solomon Islands

Phone: (677) 20101/30111 Email: researchoffice@sinu.edu.sb

2nd May, 2019

Ref No: SINUREC 01/19

Mr. Chris Vogliano
Ph.D Candidate, Massey University - Willington
Research Fellow, Bioversity International

Dear Mr. Chris Vogliano,

RE: RESEARCH ENDORSEMENT FOR CHRIS VOGLIANO (Ph.D candidate)

During its meeting on 2nd May 2019, the Solomon Islands National University Research and Ethics Committee (SINUREC) has endorsed your application to conduct research on the project entitled: *Assessing sustainable diets in three geographically distinct indigenous Solomon Islands populations.* I am pleased to advise that the Committee is satisfied that this application meets the requirements as set out in the Solomon Islands National University Ethical Research guidelines. As a result, you have been endorsed to carry out the research.

The endorsement is for the conduct of your research as specified in your proposal. Any amendments, repetitions or extensions of this research will require further Research and Ethics Committee endorsement.

The SINUREC members wish you every success in your research.

Yours faithfully,

Dr Jack Maebuta
Pro Vice Chancellor – Academic
Chair – Research and Ethics Committee
Solomon Islands National University

Appendix H: Leveraging agricultural biodiversity for sustainable diets, highlighting Pacific Small Island Developing States.

Article Title: Leveraging agricultural biodiversity for sustainable diets, highlighting Pacific Small Island Developing States.

Citation: Burlingame, B., Vogliano, C., & Eme, P. E. (2019). Leveraging agricultural biodiversity for sustainable diets, highlighting Pacific Small Island Developing States. In Advances in Food Security and Sustainability (Vol. 4, pp. 133-173). Elsevier.

Candidate involvement: Co-author; 15% contribution to this article, with a specific focus on updating to reflect latest literature in Solomon Islands

Purpose for inclusion: This publication supports the thesis of the Candidate, which focuses on agricultural biodiversity for healthy and sustainable diets within Pacific Small Island Developing States .

CHAPTER FIVE

Leveraging agricultural biodiversity for sustainable diets, highlighting Pacific Small Island Developing States

Barbara Burlingame*, **Christopher Vogliano**, **Paul Eze Eme**
Massey University College of Health Sciences, Wellington, New Zealand
*Corresponding author: e-mail address: barbara.burlingame@gmail.com

Contents

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1. Historical background

Up until a century ago, biodiversity for nutrition was the natural order. People obtained their diets out of their immediate environments. Farms and households produce a variety of plant species and local cultivars. Wild plant foods and wild terrestrial and aquatic animals were acquired from local ecosystems. Biodiversity was valued and utilized.

The historical background for agricultural biodiversity could start with Hippocrates (5th century BC) or Plato (4th century BC), and their treatises on diet. However, little if any mention is made of biodiversity, as its acknowledgment only becomes necessary in the era of modern agriculture, with reliance on mono-culture agriculture and the subsequent biodiversity loss. Therefore, the historical coverage starts in the late 19th century.

1.1 19th and 20th century documentation

Documentary evidence for the importance of biodiversity for food, nutrition and agriculture comes from many sources. It is widely estimated that

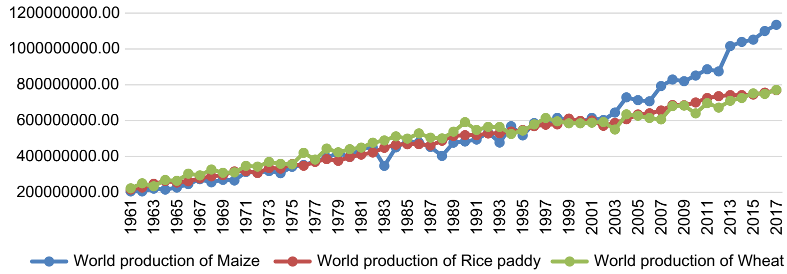

Fig. 1 Changes in global food supply for wheat, rice and maize from the 1960s through 2014. *Source: FAOSTAT.*

75,000 plants are suitable for human consumption, yet just 200 species are used regularly. Rice, maize and wheat alone provide 56% of the global dietary energy supply. There have been around 200,000 different varieties of wheat, and as many as 400,000 different varieties of rice, but much of this biodiversity has been lost.

Much of the evidence for agrobiodiversity comes from North America and Western Europe documentation which lists hundreds of varieties of common species. Calculations have been made by comparing the number of varieties of a given species offered by commercial seed houses from the early 20th century to the present day. For example, the number of muskmelon varieties decreased from 338 to a mere 27 during this period (National Geographic Magazine, 2011) (Fig. 1).

United States Department of Agriculture (USDA) Pomological Watercolors Collection provides illustrations of thousands of fruit and nut species and varieties, with nearly 4000 varieties of apples (*Malus domestica* spp.) alone. Their origin is generally believed to be Central Asia (Cornille et al., 2014) and they represent varieties introduced to the USA by plant explorers and developed by growers in the late 19th century (NAL). Also in the United States, in the 1800s, farmers and home gardeners were growing 7100 named varieties of apples. Today, 6800 of those are extinct.

1.2 Recognition of environmental sustainability issues for nutrition

The few original voices from the nutrition science community calling for conservation of biodiversity through sustainable use came from the start of the era of industrialized food production, but are echoed by many today. Those voices were barely heard then, and there were no global initiatives to amplify their voices. Nevertheless, it is worthwhile to review the history that led to the loss of so much agrobiodiversity, and to recognize some of the voices that tried to prevent this loss.

In the late 19th century, Ellen Swallow Richards was a pioneer. She was the first female environmental chemist in the United States and also the first student and later instructor at the Massachusetts Institute of Technology. Swallow is credited with introducing the word ecology into the English language, and with establishing the field nutrition as "human ecology." Recognition was given to the philosophy that human health and ecosystem health, i.e., biodiversity it all its forms, went hand in hand.

As the era of industrialized agriculture took hold, and the achievements of the Green Revolution were applauded, only a few voices were warning of the environmental consequences inherent in the dominance of monocropping, high agricultural chemical inputs to achieve ever-increasing agricultural yields, and the focus on dietary energy supply which left the provision of micronutrients to the fine chemical industries as fortificants and supplements. In the mid-20th century work of Gussow and Clancy presented the concept of sustainable diets. In their 1986 paper on Dietary Guidelines for Sustainability, they state, "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." In 1993, the theme of the International Congress of Nutrition of the International Union of Nutritional Sciences was Nutrition and Environmental Sustainability, but nutrition practice and research was still largely a medical/clinical science paying little attention to agriculture and environmental implications.

Meanwhile, the environment sector, through the Convention of Biological Diversity, was addressing the important relationship between human nutrition and environmental sustainability, and trying to redress agriculture's role in causing significant loss of biodiversity. There was a realization that the focus on promoting biodiversity in agriculture could coherently and comprehensively address both dietary and environmental problems.

1.3 Dietary change

Over many decades commitments have been made, projects and programs initiated, policies developed and implemented, and interventions undertaken to reduce the prevalence of obesity and NCDs, both globally and specifically in Pacific SIDS. For example, 17 years ago at a meeting in Samoa, renewed commitments were made to significantly reduce the multiple diet-related problems in Pacific Island countries. Then it was widely reported that the prevalence of obesity in 10 Pacific Island countries exceeded 50% of the total population of 9.7 million; about 40% had been diagnosed with a non-communicable disease, chief among them were cardiovascular disease, diabetes and hypertension. These diseases account for three-quarters of all deaths across the Pacific Islands and 40–60% of total health-care expenditure.

Failures on many levels have seen an accelerated prevalence of obesity and NCDs, and by 2017 multiple burdens of malnutrition affect all Pacific SIDS. The prevalence of overweight and obesity exceeds 80% of adult populations in the Cook Islands, Kiribati and the Republic of the Marshall Islands, Nauru, Tokelau, Tonga and Samoa (WHO, 2017). Recent work in Kiribati shows this number may be as high as 96% (Eme, 2017). An estimated 75% of all adult deaths in the Pacific are due to NCDs. On the other hand, chronic undernutrition is still a serious public health problem in some Pacific Island countries with stunting rates above 40% in Papua New Guinea according to WHO. The prevalence of anemia in children under the age of 5 years and pregnant women exceeds 40% in Papua New Guinea, Fiji, Nauru, and the Solomon Islands. This is a significant public health problem.

In Pacific SIDS, dietary change was moving quickly. Data from FAOSTAT from the early 1960 to 2014 illustrate some of those changes in rice and sugar supplies (Fig. 2). In Kiribati, data show that up to 1964, rice available for human consumption (a proxy for intake) provided around 100 kcal/cap/day. As reliance on imports steadily increased, by 2013 the average across the population was around 650 kcal/cap/day. Sugar in the early 1960s accounted for around 200 kcal/cap/day in Kiribati. Since the early 1998 it has exceeded 400 kcal/cap/day, and by 2014 it had reached 500 kcal/cap/day, bringing with it similar increases in NCDs, diabetes being the most devastating. Similar patterns of dietary change are seen in other Pacific SIDS.

Some measures have been taken to address the crises facing Pacific SIDS as they struggle to deal with both the environmental and human health consequences of dietary change. In 2007, Samoa introduced a ban on the import of high fat turkey tails and NZ mutton flaps in an effort to improve public health in a country has among the highest rates of obesity, diabetes and hypertension in the world. In 2011, due to pressure from the United States

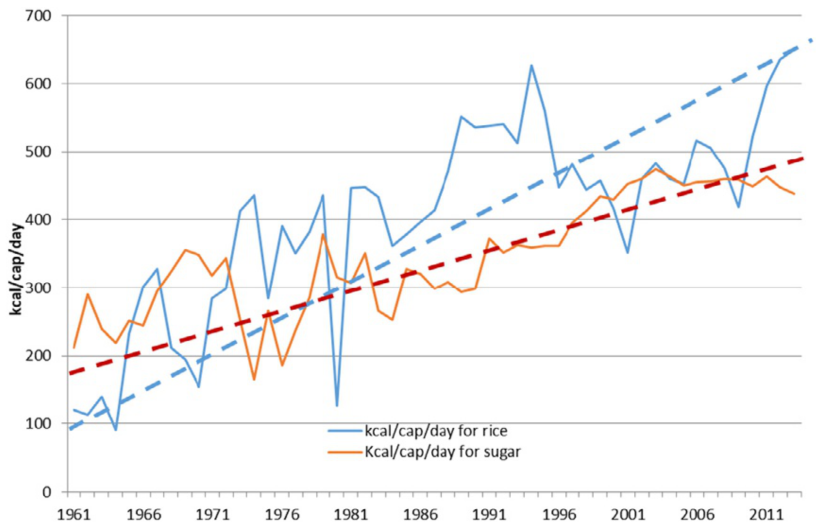

Fig. 2 Changes in food supply for rice and sugar in Kiribati from the 1960s through 2014. *Source: FAOSTAT.*

mainly, Samoa was forced to rescind this ban in order to obtain admission to the World Trade Organization. Palanitina Tupuimatagi Toelupe, Samoa's director general of health at the time was quoted as saying, "These are the contradictions we have to face—where health is compromised for the sake of trade and development."

Sugar tax was introduced in many Pacific SIDS; e.g., Fiji, French Polynesia, Nauru and Samoa have each had import and/or excise taxes in place for several years. Throughout the years, tax increases have been imposed, particularly on sugar sweetened beverages, the most recent of which was June 2017 in Wallis and Futuna. The impact of these measures is not currently well-documented.

2. The convention on biological diversity (CBD) and the cross-cutting initiative on biodiversity for food and nutrition

The Convention on Biological Diversity (CBD) and its initiatives straddle the time span between historic and current. The CBD entered into force in 1993, with three main aims: the conservation of biological diversity, the sustainable use of the components of biological diversity, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

The projects, programs, interventions and policies arising from its recommendations are specific to the topic of leveraging agrobiodiversity for nutrition, and are as relevant and applicable now as they were a decade or two ago.

There are 196 countries that are parties to the Convention; 36 are SIDS, and of these, 13 are Pacific SIDS. Each Contracting Party agreed to develop or adapt national strategies, plans or programs for the conservation and sustainable use of biological diversity and to integrate the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programs and policies.

Most countries signed up in the 1990s, but it wasn't until the mid-2000s that nutrition came into the CBD's sharp focus. In 2004, the Conference of the Parties (COP), the governing body of the CBD, issued the following decision:

> *"Noting the linkage between biodiversity, food and nutrition, and the need to enhance sustainable use of biodiversity to combat hunger and malnutrition… Requests…a cross-cutting initiative on biodiversity for food and nutrition to work together with relevant organizations, in order to strengthen existing initiatives on food and nutrition, enhance synergies and fully integrate biodiversity concerns into their work, with a view to the achievement of…relevant Millennium Development Goals."*
>
> ***(COP Decision VII/32, Kuala Lumpur, Malaysia, February 2004).***

The Committee on Genetic Resources for Food and Agriculture (CGRFA) followed up that same year by recognizing two critical areas of human nutrition that needed attention in order to effectively address nutrition, i.e., food composition and dietary assessment:

> *"…requested the Intergovernmental Technical Working Group on Plant Genetic Resources for Food and Agriculture (ITWGPGR) to 'provide guidance to FAO on how it could best support countries, on request, to generate, compile and disseminate cultivar-specific nutrient composition data, as well as indicate the relative priority of obtaining cultivar-specific dietary consumption data, in order to demonstrate the role of biodiversity in nutrition and food security.'"*
>
> ***(CGRFA, Rome, Italy, November 2004).***

ITWGPGR did indeed provide guidance and at its 3rd Session in Rome, October 2005. It recommended several specific priority actions.

1. Generating baseline nutritional data for local, regional and/or specialty foods, from underutilized crops, species utilized by local and indigenous communities, and wild food plants, taking into account local customs on food preparation. The species and target nutrients should be carefully chosen and sampling plans carefully formulated;

2. Cataloging and compiling existing cultivar-specific nutrient data into more readily accessible databases or publications;
3. Assisting countries, in particular developing countries, to build capacity to enhance the use of nutritional genetic diversity in breeding new cultivars of major crops;
4. Assisting INFOODS Regional Data Centers in their efforts to increase the quality and quantity of food composition data on individual cultivars and underutilized species, and to compile and disseminate those data in national and regional food composition tables and databases;
5. Developing communications plans for information on nutritional values of different cultivars at the national, regional and international levels;
6. Developing a biodiversity training module on nutrient composition, focusing largely on developing sampling plans in order to generate cultivar-specific data, which should be complementary to existing training courses;
7. Providing support to, and building capacity of, existing food control chemical laboratory facilities, to enable them to more economically and efficiently generate cultivar-specific nutrient data;
8. Increasing the coverage of FAO's Technical Cooperation Projects to strengthening laboratory capacity for nutrient analyses, in order to generate, compile and disseminate cultivar-specific nutrient data for national food composition databases and published food tables, in particular for underutilized crops and cultivars developed by local and indigenous communities;
9. Organizing national level sensitization, advocacy, and policy workshops, thereby supporting countries in their proposals for projects in the area of food composition and consumption, in the context of agricultural biodiversity, and publishing country-specific communication materials;
10. Conducting an expert consultation or technical workshop on addressing biodiversity in consumption survey methodologies, including an ecosystem approach to population sample stratification; and
11. Mainstreaming food composition biodiversity data into nutrition education, food security, emergency preparedness, community nutrition, activities related to indigenous knowledge, and other applied nutrition projects and programs, consistent with national law.

These recommendations were significant in that it gave recognition to the basic principle that food composition data underpin nearly all activities in nutrition. Furthermore, it acknowledged that there was a genetic resource basis for nutrient content, and this information would form the evidence base for nutrition-sensitive (or nutrition-driven) agriculture, and for addressing the multiple burdens of malnutrition, particularly micronutrient deficiencies.

For several years following the ITWGRGR meeting of 2005, significant progress was made in addressing all the recommendations—at the global level most notably by FAO, INFOODS, and Bioversity International. Major activities included two expert consultations on biodiversity indicators for food composition and food consumption, and a series of follow-up reports monitoring progress[a]; headlining biodiversity as the theme for international conferences (e.g., the International Food Data Conference and the International Conference on Diet and Activity Methods); and developing training modules and integrating elements of biodiversity into food composition training courses. Through the INFOODS Regional Data Centers, sensitization and advocacy were undertaken through workshops and training courses, and more and better nutrient data were generated on cultivars/varieties, and neglected, underutilized and wild species.

In 2006, the COP adopted the framework for a cross-cutting initiative on biodiversity for food and nutrition (Decision VIII/23A, Curitiba, Brazil, March 2006). The stated rationale is simple and straightforward, and it aligns perfectly with SDG 2:

- Biodiversity is essential for food security and nutrition, and offers key options for sustainable livelihoods.
- Promoting the broader use of biodiversity promises to contribute to improved human health and nutrition, while also providing opportunities for livelihood diversification and income generation.
- Indigenous and local communities, and the preservation of their local socio-cultural traditions and knowledge, play a critical role, as do women, for the maintenance of diverse food systems. These combined outcomes can serve to reduce poverty, providing important contributions to maintain and enhance biodiversity conservation efforts at multiple scales.
- To mainstream the conservation and sustainable use of biodiversity into agendas, programs and policies related to nutrition, health, agriculture and hunger and poverty reduction.

The Cross-cutting Initiative, often simply referred to as Biodiversity for Food and Nutrition, set in motion a number of activities, again, most

[a] FAO/INFOODS/Bioversity International (2008). *Expert Consultation on Nutrition Indicators for Biodiversity 1. Food Composition,* FAO/INFOODS/Bioversity International (2010). *Expert Consultation on Nutrition Indicators for Biodiversity 2. Food Consumption*. FAO, Rome.

notably by FAO and Bioversity International at the global level. It also, directly and indirectly, formed the basis for SDG2, as it uncoupled poverty and hunger, which had been linked in Millennium Development Goal 1, and instead coupled hunger with nutrition, biodiversity, and sustainable agriculture.

Biodiversity for food and nutrition reiterates the guidance recommendations of the ITWGPGR on food composition and dietary consumption, and provides additional guidance on other areas of human nutrition. It presents four elements, each with operational objectives, rationale, activities, and ways and means of achieving results. The elements include the following:

- *Developing and documenting knowledge* to substantiate the links between biodiversity, food and nutrition, in particular clarifying the relationship between biodiversity, dietary diversity and food preferences, and the relevant links between human health and ecosystem health.
- *Integration of biodiversity, food and nutrition issues into research and policy instruments* to mainstream the conservation and sustainable use of biodiversity into agendas, programs and policies related to nutrition, health, agriculture and hunger and poverty reduction.
- *Conserving and promoting wider use of biodiversity for food and nutrition* to counter the loss of diversity in human diets, and in ecosystems, by conserving and promoting the wider use of biodiversity for food and nutrition.
- *Public awareness* to raise awareness of the links between biodiversity, food and nutrition, and the importance of biodiversity conservation to meeting health and development objectives, including the elimination of hunger.

Unfortunately, there is no systematic mechanism in place in FAO or the CBD to monitor progress in addressing the elements of Biodiversity for Food and Nutrition. Nevertheless, the regular reports from INFOODS monitor the progress related to food composition, periodic updates from Bioversity International highlight initiatives and results from projects, and most of the regularly-issued National Reports for the CBD do mention biodiversity for food and nutrition.

The full text of Decision VIII/23A is reproduced as Annex 1.

3. Other global initiatives and policies on biodiversity for food and nutrition

Biodiversity for food and nutrition features in several current global initiatives. The Sustainable Development Goals (2015–30), Decade of

Action for Nutrition (2016–25), the Decade of Biodiversity (2011 − 20), all contain elements, targets and recommendations related to mainstreaming biodiversity for the express purpose of improving diets.

3.1 SDG 2: Human nutrition, agrobiodiversity and the need for coordinated efforts from agriculture, health and environment sectors

The short title of SDG 2 is Zero Hunger. This was the call for action, as the Zero Hunger Challenge (ZHC), from UN Secretary-General, Ban Ki-Moon, at the conclusion of the United Nations Conference on Sustainable Development—Rio + 20—in 2012. The Challenge had five pillars, the centerpiece being "All Food Systems are Sustainable." As the post-2015 development agenda was being formulated, the significance of the ZHC was enshrined as SDG2, the full title of which is "End hunger, achieve food security & improved nutrition & promote sustainable agriculture." One of the original pillars of the ZHC, zero food losses and waste, became a target in SDG 12, Responsible consumption and production, while the other four ZHC pillars were retained as targets in SDG2. Significantly, another target was added under SDG2, referencing the importance of biodiversity for food and nutrition. Table 1 shows the correspondence between the pillars of the ZHC and the SDGs.

SDG 2 is the human nutrition goal. It demonstrates clearly that human nutrition is a field of endeavor that shares equal measures of responsibility with the agriculture, health and environment sectors. Furthermore, it shows that coordinated efforts from multiple sectors are needed in order to realize the goal and achieve its targets.

Margaret Chan, in her last address to WHO's Regional Committee for the Western Pacific (67th session, Manila, Philippines 10–14 October 2016) emphasized this point: "We hear many calls for multisectoral action. But we seldom see these calls are acted upon in practical arrangements in your countries. The region enters the era of sustainable development with an exceptionally refined and comprehensive action agenda. It calls for nothing less than a transformational change in the thinking of public health, the way it organizes service delivery, and the way it interacts with other sectors. Health must move from a narrow biomedical model of disease to a mindset that embraces a holistic, integrated, people-centered approach. Again, institutional arrangements that can nurture multisectoral collaboration are a concrete way forward."

Table 1 Correspondence between pillars of the ZHC and targets of SDG 2.

Zero hunger challenge pillars	SDG 2 targets
100% access to food and nourishment all year round	Ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round
Ending stunting among children under 2 years of age	End all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons
Doubling productivity and income for smallholder farmers	Double the agricultural productivity and incomes of small-scale food producers, in particular women, indigenous peoples, family farmers, pastoralists and fishers, including through secure and equal access to land, other productive resources and inputs, knowledge, financial services, markets and opportunities for value addition and non-farm employment
Making all food systems more sustainable	Ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality
Reducing food waste and post-harvest losses	[A target in SDG 12]
	Maintain the genetic diversity of seeds, cultivated plants and farmed and domesticated animals and their related wild species, including through soundly managed and diversified seed and plant banks at the national, regional and international levels, and promote access to and fair and equitable sharing of benefits arising from the utilization of genetic resources and associated traditional knowledge, as internationally agreed

3.2 Decade of action for nutrition 2016–25

The Decade of Action for Nutrition emerged from the ICN2 and its associated Framework for Action. One of the six action areas is sustainable, resilient food systems for healthy diets. It is the statement that FAO will continue to "support countries to review and update their food and agriculture policies, strategies, investment plans and programmes with the aim of better integrating nutrition objectives for nutrition-enhancing food systems…" and that "collaboration between FAO's Departments and Divisions will be strengthened with a view to improving nutritional outcomes through optimal value chains, especially involving smallholder and family farmers and promoting consumption of fresh, healthy local products."

Biodiversity gets a single mention, as an aside, in the follow-up to the ICN2: A recent illustration of these efforts is the endorsement, by the Commission on Genetic Resources for Food and Agriculture at its 15th session (19–23 January 2015), of Guidelines for Mainstreaming Biodiversity into Policies, Programs and National and Regional Plans of Action on Nutrition. The Guidelines support the development of nutrition-sensitive agriculture that considers the nutrient composition of biodiversity for food and agriculture to address malnutrition in all its forms.

The Framework for Action [http://www.fao.org/3/a-mm215e.pdf] makes no direct reference to SIDS, nor to biodiversity per se. Nevertheless, several recommendations are relevant:

- Recommendation 8: Review national policies and investments and integrate nutrition objectives into food and agriculture policy, program design and implementation, to enhance nutrition-sensitive agriculture, ensure food security and enable healthy diets.
- Recommendation 9: Strengthen local food production and processing, especially by smallholder and family farmers, giving special attention to women's empowerment, while recognizing that efficient and effective trade is key to achieving nutrition objectives.
- Recommendation 10: Promote the diversification of crops including underutilized traditional crops, more production of fruits and vegetables, and appropriate production of animal-source products as needed, applying sustainable food production and natural resource management practices.
- Recommendation 42: Improve intake of micronutrients through consumption of nutrient-dense foods, especially foods rich in iron, where necessary, through fortification and supplementation strategies, and promote healthy and diversified diets.

Supplementation and fortification appear in several additional recommendations in the Framework for Action.

Since the first ICN in 1992, countries have been preparing and updating National Plans of Action for Nutrition (NPAN). Although biodiversity per se is rarely mentioned, recent iterations of many NPANs address issues of local food production, sustainable food production and consumption, and traditional food systems. For example, the Vanuatu NPAN (2013–15) list key objectives including enhancing the sustainable production of nutritious foods, and activities such as improving the knowledge base of farmers on diversity and traditional farming systems, and supporting the use and conservation of traditional food crops.

3.3 The strategic plan for biodiversity 2011–20

COP 10, Decision X/2 presents The Strategic Plan for Biodiversity 2011–20, and thus the basis for the Decade on Biodiversity 2011–20. The first stated rationale for the Plan is "Biological diversity underpins ecosystem functioning and the provision of ecosystem services essential for human well-being. It provides for food security, human health."

There are 25 articles in this decision. Several articles explicitly identify and emphasize three country typologies: "…in particular the least developed countries, small island developing States and the most environmentally vulnerable countries." Many Pacific Island SIDS qualify for all three.

The Strategic Plan includes 20 headline targets, i.e., the "Aichi Biodiversity Targets," organized under five strategic goals. The Goals are list below and the complete list with targets is included in Annex 2:

Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.

Goal B: Reduce the direct pressures on biodiversity and promote sustainable use.

Goal C: Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.

Goal D: Enhance the benefits to all from biodiversity and ecosystem services.

Goal E: Enhance implementation through participatory planning, knowledge management and capacity-building.

Some of the targets of particular relevance to leveraging agrobiodiversity for improving diets include the following: promote awareness of the values of biodiversity; eliminate (agricultural) subsidies harmful to biodiversity;

implement plans for sustainable production and consumption within safe ecological limits; ensure that areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity; ensure that genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives is maintained, and strategies have been developed and implemented for safeguarding genetic diversity; ensure that the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected; and that knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Listed on the CBD website are the National Reports to the Convention on Biological Diversity, with coverage for nearly all Pacific SIDS. Reports all show common themes of biodiversity loss through ecosystem degradation leading to food insecurity, multiple manifestations of malnutrition, increasing prevalences of diet-related chronic diseases and higher dependencies on nutritionally inferior imported foods.

3.4 SIDS accelerated modalities of action (SAMOA) pathway

In September 2014, the Third UN Conference on Small Island Developing States was held in Apia, Samoa. From this conference came the SAMOA Pathway—SIDS Accelerated Modalities Of Action. It included strong reaffirmations for the commitments already agreed in the Rio Declaration (1992), the Program of Action for the Sustainable Development of Small Island Developing States (1994), the World Summit on Sustainable Development (2002), the Mauritius Strategy (2005), and the outcome document of Rio + 20, which later manifested as the SDGs. The document is as relevant in 2017 as it was in 2014 when it was drafted.

Among the articles in the SAMOA pathway are several each for food security and nutrition, and biodiversity. Highlights included the following acknowledgements and commitments:

- The crucial role of healthy marine ecosystems, sustainable agriculture, sustainable fisheries and sustainable aquaculture for enhancing food security and access to adequate, safe and nutritious food;
- The danger caused by an unhealthy diet and the need to promote healthy food production and consumption;

- Promotion of sustainable practices relating to agriculture, crops, livestock, forestry, fisheries and aquaculture to improve food and nutrition security;
- The right of everyone to have access to safe, sufficient and nutritious food…while conserving, protecting and ensuring the sustainable use of biodiversity and ecosystems;
- The maintenance of natural ecological processes that support sustainable food production systems through international technical cooperation;
- The conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources;
- To facilitate the export of organic, natural, sustainably produced and locally grown products to support livelihoods; and
- To ensure access to financial and technical resources for the conservation and sustainable management of biodiversity.

Article 62 states the following: "We note the convening of the second International Conference on Nutrition in Rome in November 2014, organized by the Food and Agriculture Organization of the United Nations and the World Health Organization, which has important implications for small island developing States, and look forward to its outcome." Regrettably, none of the ICN2 documents mentions SIDS: not the Rome Declaration, not the Platform for Action, and not the Report of the Joint FAO/WHO Secretariat on the Conference.

Full texts of the food security and nutrition, and biodiversity sections of the SAMOA Pathway are shown in Annex 3.

3.5 Methodologies of assessing agrobiodiversity

Agricultural biodiversity contributes to multiple sustainability dimensions and SDGs (Fig. 3). Measuring agrobiodiversity enables researchers, policy makers, and farmers to work toward a more sustainable food system. Numerous validated methodologies and indicators have been developed for assessing agricultural biodiversity; however, quantifying biodiversity remains problematic as no single indicator is universally applicable (Morris et al., 2014). Indices include the Simpson's diversity (Simpson, 1949), Shannon's diversity (Spellerberg and Fedor, 2003), and more recently, Dietary Species Richness (Lachat et al., 2018)—each holding strengths and limitations.

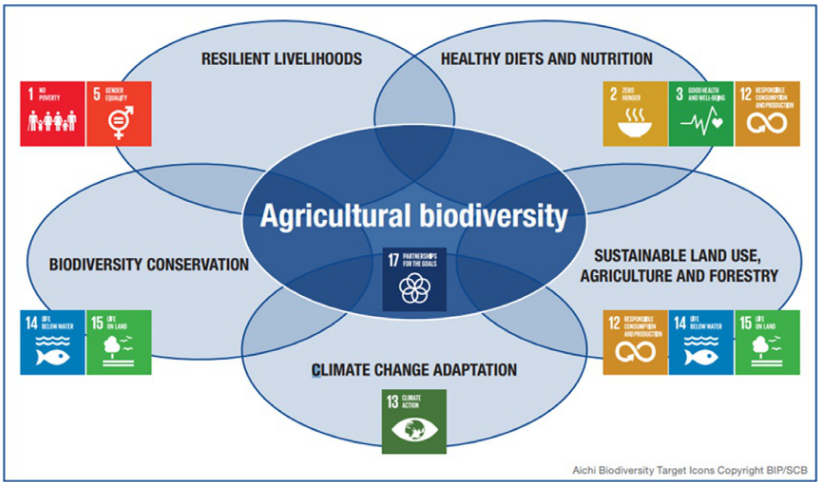

Fig. 3 Agricultural biodiversity contributes to multiple sustainability dimensions and SDGs.

Beyond conventional measures of agricultural production, metrics should include additional indicators that measure agrobiodiversity for nutritional quality, nutritional diversity, food systems, and dietary diversity (Hunter et al., 2016). As a potential solution, Bioversity International (2017) has recently developed the Agrobiodiversity Index (ABD Index) as a method of measuring agrobiodiversity in a consistent, long-term manner to be applied across all pillars of sustainable food systems. The ABD Index assesses diversity in production, food markets, consumption, conservation, and seed systems.

4. Pacific Small Island developing States (SIDS)

Pacific SIDS are not a homogeneous group, geographically representing Melanesia, Micronesia and Polynesia, with hundreds of distinctive ecosystems. Nevertheless, many of them face similar problems with respect to the conservation, management and sustainable use of their agrobiodiversity.

The biological diversity and the high degree of endemism of many species in Pacific SIDS is well known, yet not well-documented. It is estimated that over 4000 species of plants and animals are endemic and within these species are enormous numbers of cultivars, varieties and landraces. In many island states, traditional diets were based on hundreds of varieties of yams,

taros, tapioca, pandanus, mangos, bananas, green leafy vegetables and an abundance of aquatic and avian species.

The Pacific Island Food Composition Tables (2004), which represent a compilation of the very limited number of foods analyzed for nutrient contents, present data for seven species/varieties of taro (e.g., *Colocasia* spp., *Alocasia macrorrhizos*, *Cyrtosperma chamissonis*); six varieties of yam; local fruits including sapodilla, soursop, tamarind, tarawau (*Dracontomelon vitiense*); local nuts including betel nut, cut nut (*Barringtonia edulis*), pili nut (*Canarium ovatum*); local beans including winged bean and katanaku bean; local green leaves, including choko (*Sechium edule*), hibiscus (*Hibiscus* spp.), and noni (*Morinda citrifolia*); along with nutrient composition for some traditional recipes, including palusami, lap lap, and poki.

The biodiversity of Pacific SIDS is seriously threatened by a combination of natural and anthropogenic factors. Effective conservation and sustainable use of biodiversity entails the sustainable management of genetic resources for food and agriculture—forestry, fisheries and aquaculture.

Sections 4.1–4.6 list some of the significant issues affecting the ability of SIDS to leverage agricultural biodiversity for better quality diets. A single paragraph outlines the issues of relevance here, but volumes have been written about each topic individually.

4.1 Traditional knowledge loss

Indigenous knowledge of traditional foods is largely eroding, with contributing factors including the introduction of imported foods, politics, lifestyle changes, and habitat loss (Dweba and Mearns, 2011). Knowledge loss often leads to reduced consumption of traditional vegetables and an increase in nutritionally inferior ultra-processed food, resulting in decreased dietary diversity. These transitions ultimately translate into a rise of food and nutrition insecurity (Hughes and Lawrence, 2005).

4.2 Global warming, sea level rise and climate change

Global rise in sea levels is one of the most threatening consequences of global warming and is a major threat for ecosystems surrounded by seas. Climate change is among the gravest immediate threats to the planet generally, but to SIDS in particular. SIDS around the globe are perhaps the least responsible for the anthropogenic causes of climate, yet they are the most dramatically affected. The global nature of climate change calls for the widest possible cooperation by all countries in an effective global response.

The impact of climate change on Island flora and fauna will be the differences in photosynthetic potential, changes in rainfall posing risk of fire, and droughts, and migration of animals and plants and bleaching in coral reefs (Tripathi et al., 2012). Current and future climate risks include sea-level rise, cyclones, increasing air and sea surface temperatures, and changing rainfall patterns. As a result, agriculture and fisheries' resources are vulnerable, affecting food and nutrition security.

4.3 Deforestation

Deforestation and forest degradation have led to the loss, including extinction, of many animal and plants species. This irreversible loss of biodiversity, including food plants and animals, and the destruction of ecosystems, has much of its causality in agricultural expansion and overharvesting of forests. The remaining forest areas of most Pacific SIDS require urgent attention, monitoring and policy coordination.

4.4 Traditional subsistence agriculture

Traditional subsistence agriculture is practiced in more than half of all small farms in Pacific SIDS. It has the advantage of being ecologically sound, with locally adapted and resilient species and cultivars. The disadvantage, however, is low productivity. Various pressures are leading to the elimination of agroecological farming practices, such as fallow rotation systems, more reliance on commercial seed, and higher chemical and resource input systems. These practices have led to economic losses and environmental damage, including loss of biodiversity, and increases in diseases and pests, particularly crop pests that are resistant to common pesticides.

4.5 Plant and animal genetic resources

Traditional species and locally adapted varieties and cultivars are the basis for sustainable agricultural production in Pacific SIDS. Many are nutritionally superior to more commercial species and varieties, as shown in Section 6 of this report. The establishment of protected areas—forest reserves, national parks and wildlife sanctuaries, supported by botanical gardens, seed banks, etc.—is essential for conserving biological diversity. Small farmers and home gardeners need access to locally adapted seeds with high nutritional value, along with livestock and aquatic breeds and species.

4.6 Seeds

In many parts of the Asia Pacific region, a majority of farmers still rely on traditional seed systems. Farmers' seed systems must be supported (De Schutter, 2011; Santilli, 2012). The system of unregulated exchange in ensures the free flow of genetic materials, thus contributing to the development of locally appropriate seeds and to the diversity of crops. These varieties are more likely to be suited to the unique environments in which they grow, without the heavy use of inputs such as chemical fertilizers. Supporting seed systems helps all farmers and home gardeners, particularly the poorest, but also serves the interests of plant breeders and seed companies. The protection of farmers rights, support for seed banks and seed fairs, and the adaptation of seed regulations can also make an important contribution to agriculture, diets and environmental sustainability.

4.7 Marine resources

Pacific SIDS' marine ecosystems and biodiversity are especially vulnerable to damage and destruction, affecting livelihoods and food and nutrition security. Once abundant resources have become scarce. Many SIDS have depended on seafood for a high proportion of their total diets, providing not just high quality protein and micronutrients, but also a high percentage of total dietary energy intake. Dietary change to imported, high fat meat products has contributed greatly to the increases in obesity and associated chronic diseases.

5. Five pacific SIDS

The ecosystems of Pacific Island countries of Micronesia, Melanesia and Polynesia, are rich in terrestrial and marine biodiversity that would likely support sustainable diets.[b] Yet many of these SIDS are experiencing extensive loss of biodiversity and degradation of natural resources, and the nearly-11 million inhabitants have some of the highest rates in the world of obesity and associated chronic diseases. They are particularly precarious in their vulnerabilities to various manifestations of climate change and other anthropogenic and natural phenomena affecting agriculture, fisheries, food trade.

[b] Sustainable diets are 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 (Burlingame and Dernini, 2010).

Traditional diets in most Pacific SIDS were balanced and healthy; currently many of the highly nutritious traditional foods are neglected and underutilized. Modern diets in all Pacific SIDS are laden with high fat/high sugar imported convenience foods with the consequences of high rates of obesity, diabetes, heart disease, and shortened life expectancy. Some solutions to the problems are beyond the direct control of SIDS (e.g., rising sea levels), but many, including modifications to practices and policies could yield immediate benefits, e.g., conservation of local food biodiversity through sustainable use, benefiting the environment and improving nutrition.

Sections 5.1–5.5 provide some examples and context for addressing issues within the SIDS Partnership Framework, and the SAMOA Pathway, to monitor and ensure the full implementation of pledges and commitments. Tangible and immediate benefits could be realized in SIDS for nutrition and food security, public health, and for environmental sustainability, with renewed and accelerated efforts focusing on leveraging agrobiodiversity for improving diets.

5.1 Federated states of micronesia (FSM)

Many of the FSM's approximately 100,000 people depend on the country's ecosystems for their lives and livelihoods. In the context of food biodiversity, one state in FSM, Pohnpei, provides the best examples. Studies on Pohnpei's plant diversity have identified 133 breadfruit varieties, 55 bananas varieties, 171 yams, 24 giant swamp taros, 9 tapiocas and many pandanus varieties, many of which are exceptionally nutritionally rich. These foods, plus fish, coconut, and a vast diversity of fruits and vegetables, provided the diets for millennia. By mid-20th century, the modern world encroached, and traditional diets were gradually replaced with highly processed imported convenience foods, typically high in salt, sugar and fat. Dietary changes led to high prevalences of obesity and non-communicable diseases. By the early 2000s an estimated 70% of Pohnpei adults between 25 and 64 years of age are overweight (with 42.6% obese) and 32% are diabetic (WHO, 2008). Micronutrient malnutrition was affecting the population, with alarming rates of vitamin A deficiency disorders (VADD) diagnosed in children. In one study, it was shown that local foods provided 27% of the energy and 38% of the protein consumed by adults while the rest came from imported processed foods, invariably high in salt, sugar and/or fat. Few participants met the vitamin A and C recommended intakes.

Changing dietary patterns also affected the country's biodiversity, which was eroding and disappearing.

It was the diminishing diversity of fruits, particularly the deeply yellow and orange-colored bananas, coupled with the prevalence of VADD, that inspired Lois Englberger, a nutrition community worker in Pohnpei, to investigate the composition of local species. Her research revealed that local fruits, particularly some varieties of banana, had sufficient provitamin A carotenoid[c] content to largely eliminate VADD in the state.

Table 2 compares the β-carotene content of three banana varieties. It shows that a 100 g serving of the common Cavendish banana provides <1% of a child's daily vitamin A requirement. A mere 25 g of the *Utin Iap* variety, on the other hand, would provide 100% of the recommended intake, eliminating the need for other forms of vitamin A intervention such as supplementation, fortification and biotechnological modifications.

Many FSM communities practice agroforestry, a farming system characterized by multi-storied crop production, including root crops such as taro and yam, and food trees such as banana, coconut, and breadfruit. These agroforests occupy about 35% of the country's landmass. Local food markets are developing across the FSM, providing income, as well as improved diets, from agroforestry.

Renewed attention to agriculture is helping preserve the region's genetic agrobiodiversity. Programs are giving farmers wider access to different local varieties of food crops. The "Let's Go Local" initiative of the Island Food Community of Pohnpei has made plantings of >50 varieties of bananas available to residents. Studies have shown that people are increasingly

Table 2 Impact of biodiversity on measurements of dietary adequacy: Cavendish banana vs two varieties of indigenous Pacific Island bananas.

Banana variety	β-Carotene content μg/100 g	Vitamin A (retinol equivalents) μg/100 g	% vitamin A RDI for child[a] 1–3 years and 4–8 years	% vitamin A RDI for adult[b] Women and men
Cavendish	26	4	<1%	<1%
Lacatan	360	60	20% and 15%	9% and 7%
Utin Iap	8510	1400	>400%	>150%

[a]Australia/New Zealand Nutrient Reference Values: RDI for children 1–3 years = 300 μg/day; for children 4–8 years = 400 μg/day.
[b]Australia/New Zealand Nutrient Reference Values: RDI for women = 700 μg/day; for men = 900 μg/day.
Source: https://www.nrv.gov.au/nutrients/vitamin-a

appreciative of the many advantages of "going local"—nutritional, environmental, economical, and providing support for a community of local growers.

5.2 Vanuatu

The Government of the Republic of Vanuatu declared the first year of the new century "the year of local produce," or "Yia blong Aelan Kakai" in Bislama language. Much like the "Let's Go Local" campaign of FSM, vision of this national campaign was to remind the population of the need to preserve local food resources in the face of mounting pressures to globalize agriculture and food markets. The campaign persuaded ni-Vanuatu to have pride in their organically produced foods, and to appreciate the diversity of their local products, which had been neglected and underutilized. The history of the food plants found in Vanuatu, their botanical descriptions, the morphological and agronomic variability found within the species, details of cultivation, and their culinary uses have been documents in an ACIAR monograph. However, little information exists on the nutrient composition.

5.3 Kiribati

Kiribati reports in its recent National Report to the CBD that its terrestrial biodiversity is not particularly rich or endemic and what exist is threatened by human development and expansion activities across a limited land area. Its indigenous land based flora and fauna are limited and among the poorest on earth. Much of this has to do with poor soil quality. There is a decline in traditional staple food crop include the Pandanus (*Pandanus tectorius*), breadfruit (*Artocarpus mariennesis*, *A. altilis*, *A. mariennesis*), giant swamp taro (*Cyrtosperma merkusii*), native fig (*Ficus tinctoria*) and coconut (*coco-nucifera*). Other important plants were observed to have declined and these are Te Kiaiai (beach hibiscus), te ukin (beach almond), te uri (Guettarda), te ren (tree and beach heliotrope) and Te mao. Kiribati is heavily dependent on food imports, and has a high prevalence of obesity and diet-related chronic diseases. Food consumptions surveys are regularly undertaken, including in 2017, but few attempt to capture consumption of local food biodiversity.

5.4 Solomon islands

Over 900 islands comprise the Solomon Islands, which contain vast cultural and ecological knowledge. These islands are home to diverse indigenous

food systems, which have played an integral role for the over 600,000 present day Solomon Islanders. Over three-quarters of Solomon Islanders live in rural indigenous villages, and 89% still rely on subsistence agriculture for the majority of their nutrition and energy (Solomon Island National Statistics Office (SINSO), 2018). The Solomon Islands are recognized as a "Centre of Plant Diversity," and are home to 4500 different species of plants—3200 of which are indigenous and at least 120 are edible (Convention on Biological Diversity, 2015). One example of a nutrient-dense indigenous food is the Fe′i banana cultivar (*Musa* × *troglodytarum* L.) from the Makira region, which is a rich source of provitamin A and riboflavin (Englberger et al., 2010). A failure of ecology and agrobiodiversity conservation is leading to a rise in malnutrition (Andersen et al., 2013).

5.5 Tuvalu

The 5th National Report to the CBD from Tuvalu is particularly comprehensive, addressing all the themes and objectives, and their status as implemented, completed, ongoing and planned actions. Some relevant excerpts from the report include the following statements about biodiversity, agriculture and nutrition:

- although there is no stark poverty and hunger as found in some countries, there are serious issues related to food security and food dependency, sustainable agriculture and fishing, and the increasingly serious levels of malnutrition and nutrition-related non-communicable diseases that are strongly linked to a shift from diets based on nutritious local foods to a dominance by nutritionally inferior imported foods and drinks.
- over the past 20 years or more, to improve nutrition and increase production and consumption of vitamin-rich vegetables and fruits in an effort to reduce the dependence on nutritionally inferior, highly processed imported foods and drinks that are the main causal factor in the rapid increase in obesity, diabetes, cardiovascular and dental disease and a range of other "lifestyle diseases" in Tuvalu.
- increasing food and import dependency and associated nutrition-related non-communicable diseases.
- This is particularly serious on Funafuti where recent surveys show that from 20% to 30% of female and male children suffer from malnutrition induced stunted growth due an over dependence on nutritionally poor imported staple foods, meats, soft drinks, etc.; and there is an almost

epidemic incidence of nutrition-related non-communicable disease (e.g., diabetes, hypertension and cardiovascular disease) and early mortality (Ministry of Health, 2011). There is also a need to address maternal-child mortality related diseases and cases of pollution-related diseases.

The impacts which have negative effects on the agriculture sector include less food being produced locally, more imported food, loss of traditional agricultural practices, and prevalent spread of invasive species. The effects of rapid development in the main urban centers, as well as climate change (particularly changing rainfall patterns, drying out of soil and water land lenses, and saltwater intrusion) have further exacerbate the agriculture sector and the will of the people. Reduced agricultural output is also affected by globalization. For example, the relatively low price of imported food, and the challenges of transporting locally produced crops, makes it harder for local farmers to market their produce.

6. Technology and innovation

In his final report to the United Nations General Assembly, 2014, Olivier De Schutter, UN rapporteur on the right to food, stated the following: "Only agricultural diversity can ensure food security and resilience. Too often, these arguments (against agricultural biotechnology) are dismissed as techno-phobia. We are told that the opponents of industrial agriculture want to eschew technological advance and keep developing regions mired in non-mechanised, subsistence-style agriculture. However, this is a false dichotomy."

It is well-recognized that technology and innovation are needed to solve the pressing problems inherent at the nexus of health, agriculture and the environment. It is equally well-recognized that technology and innovation have caused many of today's pressing problems. This is particularly true for Pacific SIDS.

This section will address only three simple topics requiring technology and innovation: food composition, fortification, and Biofortification.

6.1 Food composition

As scientists in biotechnology companies and the food industries strive for genetic improvements in food crops and animals, other scientists have been glancing back in time to study traditional food systems and diets as ecosystem services. Neglected crops, non-commercial foods, wild foods, and indige-nous edible species are receiving new attention from many international, regional and national governments and agencies. FAO reports least a billion people use wild plants, animals, tree foods and forest foods, and that they are essential for many rural households. In some parts of the world, wild plants and animals provide a greater share of the diet than domesticated cultivars. There is still much to know about the nutrient content of these foods. In some published reports and on many Web sites, these foods are promoted as nutritionally superior, without the backing of proper analytical data.

The work of INFOODS on food composition has been recognized as fundamental to the understanding of how agriculture can move from an industrial, mono-culture, yield-based model to one that is nutrition-driven and environmentally sound. Knowledge of the nutrient content of foods that form the ecosystem is necessary in order to develop policies and programs for most nutrition interventions, including (bio)fortification. The CBD, the CGRFA, and their associated technical committees and working groups have all recommend support for INFOODS and national level food composition programs. This support has not been realized.

It should be noted that OCEANIAFOODS, which covers the SIDS of the Pacific, has been significantly under-resourced. The Pacific Islands Food Composition Tables, last published in 2004, are in desperate need of updating, in order to implement evidence-based policies and programs to address the multiple burdens of malnutrition, and to reverse the loss of local food biodiversity.

6.2 Fortification

Fortification is one of the food-based strategies for addressing the problem of micronutrient malnutrition. In Pacific SIDS, fortification does not seem to be widely used for local food industries, with the exception of iodized salt. GAIN (Global Alliance for Improved Nutrition) does not list any Pacific SIDS on its website, nor does the Micronutrient Initiative, both of which deliver food fortification interventions around the world. Policies and interventions for fortification should be informed by evidence, i.e., knowledge of the nutrient content of foods in the food supply of a country or agroecological zone, and food consumption data. These types of data are generally lacking for most Pacific SIDS.

6.3 Biofortification

Biofortification is another of the food-based strategies for addressing micronutrient malnutrition. This technology can involve either agricultural biotechnology (e.g., the case of Golden Rice), or traditional breeding methods (e.g., the case of orange sweet potato). Many of the high carotenoid, deeply

hued orange varieties of sweet potato varieties used in the breeding program by the International Potato Centre (CIP), are indigenous to the Pacific. Biofortification programs such as those promoted by Harvest Plus and initiated by CIP and others, have selected high nutrient crop varieties for breeding with varieties showing traits for high yield, improved disease resistance, higher tolerance to heat/drought/flooding/salinity. Nutrient composition data at the level of the variety are necessary for this technology to continue to deliver. In the case of sweet potatoes, biodiversity, not biotechnology, is the hero.

7. Conclusions and recommendations

In the era of the SDGs, the calls are loud and clear for improved cross-sectoral collaborations and partnerships, more effective trans- and interdisciplinary working relations. Never was it more critical than for leveraging agriculture and biodiversity for improving nutrition and health.

It is pointless, indeed counter-productive, to create new and competing goals and targets for dealing with the multiple crises facing the world. It is far better, and greatly more practical, to double-down with new resolve to achieve targets and goals, along with policy recommendations, that have already been agreed.

Since the adoption of the cross-cutting initiative on biodiversity for food and nutrition, and subsequent exposure and reiteration through a number of national and global initiatives, the role of biodiversity in contributing to solutions to the problems of malnutrition has been clear and irrefutable. Inaction and delayed reaction times have resulted in multiple crises in Pacific Island countries. The challenge remains to re-focus agriculture policies to encourage mainstreaming so that local and traditional foods will have a place of prominence in diets, that biodiversity loss will be reversed, and that the combined nutrition, biodiversity and sustainable food systems' goals and targets will be realized.

Conflict of interest disclosure

Nothing to declare.

Annex 1. Elements of the cross-cutting initiative on biodiversity for food and nutrition

COP 8 Decision VIII/23, https://www.cbd.int/decision/cop/?id=11037

Element 1. Developing and documenting knowledge

Operational objective 1

To substantiate the links between biodiversity, food and nutrition, in particular clarifying the relationship between biodiversity, dietary diversity and food preferences, and the relevant links between human health and ecosystem health.

Rationale

Current evidence on the links between biodiversity, food and nutrition is sufficient to warrant immediate action, but more work is needed. Developing and documenting knowledge of these links will provide a sound scientific basis for the initiative, allowing for the better design of activities, and the development of comprehensive public awareness-raising initiatives on the importance of biodiversity to human diets and health, and the link between human health and ecosystem health.

Activities

1.1 Compilation, review and analysis of:

- **(a)** Existing scientific information, indigenous and traditional knowledge on the links between biodiversity, food and nutrition (in a manner consistent with Article 8(j) and related provisions of the Convention) according to national legislation;
- **(b)** Case-studies on the links between biodiversity, food and nutrition;
- **(c)** The value of biodiversity for food and nutrition.

1.2 Stimulating further research and the generation and systematic compilation of new data.

1.3 Development of an indicator (or indicators) on biodiversity in use for food, consistent with decision VII/30.

Ways and means

FAO and IPGRI will take the lead on developing the evidence base for the initiative. IPGRI will work with FAO to increase the usability, for the initiative, of existing FAO databases and information resources. The first report of the State of the World's Animal Genetic Resources and the second report of the State of the World's Plant Genetic Resources, among other resources, will contribute to building the evidence base for the initiative. In addition, FAO, through its Commission on Genetic Resources for Food and Agriculture, could support countries in generating, compiling and disseminating

new cultivar-specific nutrient composition data, as could the CGIAR International Agricultural Research Centers, through the HarvestPlus initiative. An examination of available data will serve to identify where in-depth case studies would be most useful. On the basis of knowledge gathered, FAO, IPGRI and the Secretariat could support, in collaboration with relevant partners, development of the indicator(s) and related activities as outlined under other elements of the initiative (e.g., development of a communication strategy). Noting the role of Parties, other Governments and relevant national and regional organizations as the primary source of data, there is a need to identify mechanisms to strengthen local infrastructure and human resources for the generation of such data.

Element 2. Integration of biodiversity, food and nutrition issues into research and policy instruments

Operational objective 2

To mainstream the conservation and sustainable use of biodiversity into agendas, programs and policies related to nutrition, health, agriculture and hunger and poverty reduction.

Rationale

Existing research and policy instruments often overlook the importance of biodiversity and associated knowledge in addressing local problems of hunger and malnutrition. In nutrition studies, the most commonly used research instruments aggregate food data into broad categories, obscuring the contribution of individual species or cultivars to human nutrition and health. Under prevailing regulatory frameworks, food quality standards that are not adapted to local foods may also inadvertently constrain food producers, limiting their ability to provide an array of species and varieties to markets. Policies, programs and projects aimed at addressing poverty reduction and food security sometimes emphasize the provision of staple food sources and dietary supplements while overlooking the value of locally available diverse food sources. In these cases, the value of biodiversity for food and nutrition, especially to poor and disadvantaged groups, is not fully realized. A proactive focus on biodiversity will be needed in order to encourage practitioners and researchers to modify current approaches, and to shift research and policy emphasis toward examining issues of food quality, and not simply food quantity.

Activities

2.1 As appropriate, integrate biodiversity concerns into nutrition instruments, inter alia:
- **(a)** Food-based dietary guidelines;
- **(b)** Food composition analysis and dietary assessments;
- **(c)** National policies and plans of action for nutrition; and
- **(d)** Relevant regulatory frameworks and legislation at national and international levels.

2.2 Integrate biodiversity for food and nutrition concerns into food security and poverty reduction strategies, inter alia:
- **(a)** National Poverty Reduction Strategy Papers;
- **(b)** The right to food;
- **(c)** Food security projects and programs, including: household food security projects, school feeding programs, home gardens; and
- **(d)** Emergency response and preparedness.

Ways and means

FAO, IPGRI, WHO, SCN and the Secretariat, as appropriate, will work with relevant partners to advance activities under this element, including through their work on the development of standards, and provision of support to member countries, their agencies responsible for nutrition, universities, and extension services, acknowledging them as the primary beneficiaries of the initiative.

Element 3. Conserving and promoting wider use of biodiversity for food and nutrition

Operational objective 3

To counter the loss of diversity in human diets, and in ecosystems, by conserving and promoting the wider use of biodiversity for food and nutrition.

Rationale

Diversity is being replaced by uniformity in the agricultural market place, and in human diets more generally. Yet a diverse resource base remains critical to human survival, well-being, the elimination of hunger and providing the basis for adaptation to changing conditions (including environmental change). Promoting the broader use of biodiversity promises to contribute to improved human health and nutrition, while also providing opportunities for livelihood diversification and income generation. Indigenous and local communities, and the preservation of their local socio-cultural traditions

and knowledge, play a critical role, as do women, for the maintenance of diverse food systems. These combined outcomes can serve to reduce poverty, providing important contributions to maintain and enhance biodiversity conservation efforts at multiple scales.

Activities

3.1 Conservation and sustainable use of crop and livestock genetic diversity, including wild relatives of domesticated animals and plants.

3.2 Identification and promotion of species currently underutilized or of potential value to human food and nutrition, including those important in times of crisis, and their conservation and sustainable use.

3.3 Promotion of genetically diverse and species-rich home gardens, agroforestry and other production systems that contribute to the in situ conservation of genetic resources and food security.

3.4 Conservation and sustainable use of wild resources, including those that support bushmeat and fisheries, including maintaining viable stocks of wild species for sustainable consumption by local and indigenous communities.

3.5 Promotion, conservation and sustainable use of important biodiversity, at all levels associated with agricultural, forestry and aquaculture systems.

3.6 Conservation and sustainable use of medicinal species relevant for food and nutrition.

3.7 Support all forms of food production of indigenous and local communities, in accordance with Article 8(j) and related provisions of the Convention.

3.8 Identifying and promoting crop diversification for biodiverse food crops to be used for food and nutrition.

3.9 Protection and promotion of biodiversity friendly markets by addressing regulatory issues.

3.10 Promotion of technology transfer to improve technical capacities of developing countries and countries with economies in transition, for the conservation and sustainable use of important species, wild relatives, neglected and underutilized species.

3.11 Research and conservation of native plants or animals, local races, wild relatives of cultivated or domesticated species in order to improve the knowledge on their genetic variability, regarding important traits for agriculture such as: biotic/abiotic resistance, yield and nutritional value.

3.12 Use of biodiversity to broaden the genetic base of cultivated crops to, increase food production and improve the nutritional value of food while taking into account the environmental impact of agriculture.
3.13 Support to the study and development of production and commercialization of non-conventional biodiversity-based products, including processing of non-conventional biodiversity-based food.
3.14 Strengthening of local infrastructure and human resources training in order to establish standards of identification and quality of daily admissible ingestion.
3.15 Transforming and/or treating residues of processed raw materials.
3.16 Integration of benefit-sharing objectives into national and international frameworks dealing with biodiversity for food and nutrition, as appropriate, taking into account existing benefit-sharing systems.

Ways and means

Most of the activities outlined under this element will be pursued under the Convention's existing program of work on agricultural biodiversity, and the FAO Global Plan of Action for the Conservation and Sustainable Utilization of Plant Genetic Resources for Food and Agriculture. In particular, activities 2, 4, 11 and 12 of the Global Plan of Action could advance activities under the initiative for the conservation and diversification of plant genetic resources. Action under the Global Strategy for Plant Conservation (in particular, under target 9) will also contribute to the conservation of plant genetic diversity. In considering the role of animal products in relation to nutrition, the Global Strategy for the Management of Farm Animal Genetic Resources provides an important technical and operational framework for guiding activities on conserving animal genetic diversity. In terms of market-related activities, activity 14 of the Global Plan of Action will support the development of markets for biologically diverse food products. In addition, there are opportunities for cooperation with the BioTrade Initiative of the United Nations Conference on Trade and Development (UNCTAD) to, inter alia, provide technical assistance and create an enabling policy environment. Planned activities could be tested through pilot projects in selected countries, in order to evaluate effectiveness and develop approaches.

Element 4. Public awareness

Operational objective 4

To raise awareness of the links between biodiversity, food and nutrition, and the importance of biodiversity conservation to meeting health and development objectives, including the elimination of hunger.

Rationale

Biodiversity programs and policies can be made more relevant to policymakers and stakeholders, and more effective on the ground, by making clear the crucial links between biodiversity and human well-being. When rural people perceive that biodiversity has greater value through positive impacts on both income and health, they are more likely to maintain and protect it. In addition, issues of food production as they relate to nutrition and health can serve to mobilize both urban and rural consumers who may not otherwise be motivated by environmental or ethical arguments to support agricultural sustainability. Food security issues can then serve as a way to re-establish links between local production and global consumption, and between the rich and poor.

Activities

4.1 Development of a communication strategy, and associated publications and other materials to address the general public, decision makers, local communities, and the nutrition, agriculture, health and environment communities.

4.2 Convening of regional and national workshops to raise awareness of the links between biodiversity, food and nutrition, and of activities supporting these links.

Ways and means

Awareness-raising activities would be integrated under the Convention's program of work on communication, education and public awareness, and related activities by FAO, IPGRI, WHO and other relevant organizations. Activities under target 14 of the Global Strategy for Plant Conservation would further support implementation of this element.

Annex 2. Strategic goals for biodiversity 2011–2020 and the AICHI biodiversity targets

The Strategic Plan includes 20 headline targets for 2015 or 2020 (the "Aichi Biodiversity Targets"), organized under five strategic goals. The goals and targets comprise both: (i) aspirations for achievement at the global level and (ii) a flexible framework for the establishment of national or regional targets. Parties are invited to set their own targets within this flexible framework, taking into account national needs and priorities, while also bearing in mind national contributions to the achievement of the global targets. Not all countries necessarily need to develop a national target for each

and every global target. For some countries, the global threshold set through certain targets may already have been achieved. Others targets may not be relevant in the country context.

Strategic goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.

Target 1: By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.

Target 2: By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.

Target 3: By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.

Target 4: By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.

Strategic goal B: Reduce the direct pressures on biodiversity and promote sustainable use.

Target 5: By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.

Target 6: By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.

Target 7: By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.

Target 8: By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.

Target 9: By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.

Target 10: By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.

Strategic goal C: Improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.

Target 11: By 2020, at least 17% of terrestrial and inland water areas, and 10% of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.

Target 12: By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.

Target 13: By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.

Strategic goal D: Enhance the benefits to all from biodiversity and ecosystem services.

Target 14: By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.

Target 15: By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15% of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.

Target 16: By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.

Strategic goal E: Enhance implementation through participatory planning, knowledge management and capacity-building.

Target 17: By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.

Target 18: By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.

Target 19: By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.

Target 20: By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011–20 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.

Annex 3. SIDS accelerated modalities of action (SAMOA) pathway

Food security and nutrition

59. We recognize that Small Island developing States, primarily net food-importing countries, are exceptionally vulnerable to the fluctuating availability and excessive price volatility of food imports. It is therefore important to support the right of everyone to have access to safe, sufficient and nutritious food, the eradication of hunger and the provision of livelihoods while conserving, protecting and ensuring the sustainable use of land, soil, forests, water, plants and animals, biodiversity and ecosystems. We stress the crucial role of healthy marine ecosystems,

sustainable agriculture, sustainable fisheries and sustainable aquaculture for enhancing food security and access to adequate, safe and nutritious food and in providing for the livelihoods of the people of the Small Island developing States.

60. We also recognize the danger caused by an unhealthy diet and the need to promote healthy food production and consumption.

61. We recognize the call, in the outcome of the interregional preparatory meeting for the third International Conference on Small Island Developing States, adopted in Bridgetown on 28 August 2013, UN General Assembly (2014) to facilitate a meeting on food and nutrition security in Small Island developing States in order to develop an action program to address food and nutrition challenges facing those States, and we invite the Food and Agriculture Organization of the United Nations to facilitate this biennial forum.

62. We note the convening of the second International Conference on Nutrition in Rome in November 2014, organized by the Food and Agriculture Organization of the United Nations and the World Health Organization, which has important implications for Small Island developing States, and look forward to its outcome.

63. In this regard, we are committed to working together to support the efforts of Small Island developing States:

- **(a)** To promote the further use of sustainable practices relating to agriculture, crops, livestock, forestry, fisheries and aquaculture to improve food and nutrition security while ensuring the sustainable management of the required water resources;
- **(b)** To promote open and efficient international and domestic markets to support economic development and optimize food security and nutrition;
- **(c)** To enhance international cooperation to maintain access to global food markets, particularly during periods of higher volatility in commodity markets;
- **(d)** To increase rural income and jobs, with a focus on the empowerment of smallholders and small-scale food producers, especially women;
- **(e)** To end malnutrition in all its forms, including by securing year-round access to sufficient, safe, affordable, diverse and nutritious food;
- **(f)** To maintain natural ecological processes that support sustainable food production systems through international technical cooperation.

Biodiversity

89. We agree to promote international cooperation and partnerships, as appropriate, and information exchange, and in this context we welcome the United Nations Decade on Biodiversity, 2011–20, for the purpose of encouraging the active involvement of all stakeholders in the conservation and sustainable use of biodiversity, as well as their access to and the fair and equitable sharing of benefits arising from the utilization of genetic resources, with the vision of living in harmony with nature.

90. We recognize that, overall, Small Island developing States have extraordinary marine and terrestrial biodiversity that in many cases is fundamental to their livelihoods and identity. Noting that this valuable biodiversity and the ecosystem services it provides are at grave risk, we strongly support the efforts of Small Island developing States:

(a) To conserve biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources;

(b) To export organic, natural, sustainably produced and locally grown products;

(c) To access financial and technical resources for the conservation and sustainable management of biodiversity.

91. We invite parties to the (Convention on Biological Diversity, 2015) to consider ratifying and implementing the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from Their Utilization to the Convention on Biological Diversity, while acknowledging that having access to and sharing the benefits of genetic resources contribute to the conservation and sustainable use of biological diversity, poverty eradication and sustainable development.

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Appendix I: Dietary assessment methodologies in PSIDS: A Scoping Review

Article Title: Dietary assessment methodologies in PSIDS: A Scoping Review

Status: Protocol submitted to JBI Evidence Synthesis and is featured below. Review process in progress.

Candidate involvement: Co-author. 30% contribution, assisting with scoping review design and assessment of relevant literature for inclusion in the article.

Purpose for inclusion: A scoping review examining and comparing methodological approaches towards assessing dietary intake is needed in the Pacific, as currently no accepted standard exists for doing so within these geographically and culturally unique Indigenous populations.

JBI Evidence Synthesis

Dietary assessment methodology and reporting in Pacific Island research: a scoping review protocol

--Manuscript Draft--

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Dietary assessment methodology and reporting in Pacific Island research: a scoping review protocol

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Dietary assessment methodology and reporting in Pacific Island research: a scoping review protocol

Abstract

Objective: This scoping review aims to examine the conduct of research on dietary assessment methodologies in Pacific Island countries.

Introduction: Dietary assessment explores associations between dietary factors and health outcomes. In regions such as the Pacific Islands where diet-related non-communicable diseases are increasing, this is a growing area of research. As this information is used to inform food and nutrition policies and practice, accurate collection, analysis and interpretation of dietary assessment data relies on robust methods. A greater understanding of how nutrition studies are designed can strengthen the evidence on nutrition and health in Pacific Island research and inform future research approaches.

Inclusion criteria: The scoping review will consider studies published in peer-reviewed journals, including both experimental and observational study designs and grey literature including government reports, research reports, theses and dissertations that measure and/or assess dietary intake in resident populations of the Pacific Island member countries of the Secretariat of the Pacific Community: American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kirabati, Mariana Islands, Marshall Islands, Nauru, New Caledonia, Niue, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Wallis and Futuna.

Methods: There will be no time limit and searches will be conducted in: PubMed, CINAHL, CABI, Scopus, Cochrane Library and Web of Science. Results will be limited to English language articles. Data will be extracted independently by two reviewers into a charting table. Results will be presented graphically and with tables accompanied by a narrative summary.

Keywords: dietary data; dietary patterns; food composition; non-communicable disease; pacific islanders

Introduction

Assessment of dietary intake is used to monitor the nutritional quality of food consumed by populations, to explore associations between nutrients, dietary patterns, and health outcomes,[1] and to inform food and nutrition policies and practice.[2] Suboptimal diet is a leading contributor to the global burden of disease,[3] yet one of the largest challenges in nutrition research is the assessment and reporting of dietary intake.[2, 4]

Accurate analysis and interpretation of dietary assessment data relies on robust methods and many dietary assessment methods are available to facilitate the process,[4] all of which have methodological considerations.[5] Dietary assessment methods use specific tools or instruments to gather dietary data and may integrate technology to improve the process.[5] Methods can be indirect, for example food balance sheets or household consumption surveys, or direct, for example food frequency questionnaires, 24-hour recalls, dietary histories, food records or duplicate meal method.[5]

Pacific Island Countries and Territories (PICT) have some of the highest reported rates of diet-related non-communicable diseases (DR-NCD).[3] Key contributing aspects include political, environmental and economic changes which have influenced a nutrition transition from traditional dietary patterns to greater reliance upon packaged and imported foods.[6, 7] Although several PICT studies have examined the relationship between dietary intake and health outcomes,[8, 9] the validity of dietary assessment methods in nutrition transition research in islander communities has been questioned.[10] Further, dietary assessment tools used in research often rely on self-reporting by participants, hence, measurement error must be considered and addressed when interpreting study findings.[2, 11-13]

Given this is a growing area of research, it is necessary to examine the conduct of research on dietary assessment in PICT. A greater understanding of how nutrition studies are designed can strengthen the evidence on nutrition and health in Pacific Island research and inform future research approaches. A scoping review is an appropriate method[14] to examine dietary assessment in PICT as it facilitates the synthesis of research evidence to date by mapping methods, tools, reporting and limitations in PICT nutrition research. The aim of the review is not to critique studies but to identify patterns and highlight any gaps to inform the design of future research studies. This article presents the protocol that will inform the scoping review and follows the framework provided by the Joanna Briggs Institute (JBI).[15]

Prior to the development of this protocol, a preliminary search was conducted to identify any previously published reviews on this topic. The search was conducted in December 2019 in the following databases: CABI databases, JBI Database of Systematic Reviews and Implementation Reports, Cochrane Library, PROSPERO International Prospective Register of Systematic Reviews, and Epistemonikos using the keywords: “diet*” AND “assess*” AND “Pacific”. Two systematic reviews were identified however one had a specific focus on fat, sugar and salt intake[8] and a second examined fish access and intake.[9] No other systematic or scoping reviews were found that were either published or registered on this topic. The objective of this scoping review is to examine the conduct of research on dietary assessment methodologies in PICT. It will identify, describe, and map dietary assessment methods, tools and analyses used in the evaluation of dietary intake of Pacific Island populations.

Review questions

The scoping review aims to assess how dietary data are collected and reported in PICT research. The specific review questions are:

1. What dietary assessment methods and tools are used for collecting dietary information in Pacific Island research?
2. What types of dietary information is collected in Pacific Island research?
3. Which food composition tables or nutrient databases are used to estimate the nutrient content of foods in Pacific Island research?
4. What dietary factors and health outcomes are investigated and analysed in Pacific Island research?
5. What methodological limitations are reported in dietary assessment studies (e.g. validity, reliability, measurement errors, availability of nutrient composition data)?

Inclusion criteria

Participants

The scoping review will consider all studies that include Pacific Islanders of all ages living in the community setting in PICT with or without DR-NCDs.

Concept

The proposed scoping review is designed to summarise dietary assessment methodology and reporting in PICT populations. The review will consider experimental design and observational nutrition studies that measure and/or assess dietary intake in PICT populations.

Context

The scoping review will consider studies that focus on PICT identified as member countries of the Secretariat of the Pacific Community (SPC)[16] and include:

American Samoa, Cook Islands, Federated States of Micronesia, Fiji (Republic of), French Polynesia, Guam, Kirabati, Mariana Islands (CNMI), Marshall Islands (Republic of), Nauru, New Caledonia, Niue, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu (Republic of), Wallis and Futuna.

Migrant populations living in other countries will be not be included.

Types of studies

This scoping review will consider all available publications that investigate dietary assessment of Pacific Islanders living in PICT. The review will consider studies published in peer-reviewed journals, including both experimental and observational study designs and grey literature including government reports, research reports, theses and dissertations. Only English language papers will be included in this review due to this being the only language reviewers understand as well as time and budget constraints.

Methods

The proposed scoping review will be conducted in accordance with the Joanna Briggs Institute (JBI) methodology for scoping reviews.[15]

Search Strategy

A three-step search strategy[15] will aim to locate all eligible studies both published and unpublished studies. First, to identify search terms, an initial limited search of PubMed and CABI was undertaken. The initial search terms are provided in Appendix I. Second, in consultation with a research librarian, identified keywords and index terms will be used to develop the search using relevant syntax. This will be used across all included databases (and other sources for grey literature). No time restrictions will be placed on databases searched.

The databases to be search include the following:

- PubMed
- CINAHL
- CABI
- Scopus
- Cochrane Library
- Web of Science

The search for dissertations and theses will include: ProQuest Dissertations and Theses; TROVE; and Networked Digital Library of Theses and Dissertations. Other grey literature will be located by searching Google Scholar and by contacting experts of organisations involved in healthcare and food provision in the Pacific Islands, for example the Food and Agriculture Organization of the United Nations (http://www.fao.org). Third, the reference list of all identified reports and articles that have been included will be searched for additional studies. The selection process will be recorded in a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram.[17]

Study selection

Following the search, all identified citations will be collated and uploaded into EndNote X9 (Clarivate Analytics, PA, USA) and duplicates removed. References from EndNote will next be imported to Covidence systematic review software (Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org). Titles and abstracts will be screened by two independent reviewers for assessment against the inclusion criteria. Full text articles will be retrieved if they appear to meet the inclusion criteria or if further examination is required to determine eligibility. Full text screening will then be undertaken to further determine study eligibility for inclusion in the review. Full text studies that do not meet the inclusion criteria will be excluded and reasons will be provided in an appendix in the final scoping review. Any disagreements will be resolved by consensus or by the decision of a third reviewer.

Data extraction

Data will be extracted from the included papers independently by two reviewers using a structured data extraction form based upon the research questions. Relevant content will be extracted from each study as per the draft table presented in Appendix 2. Charting of results will be an iterative process and the extraction table may be updated and further refined during the review. Discussion of any changes will be included in the presentation of results. Any disagreements that arise between reviewers will be resolved through discussion or with a third reviewer. Where required, authors of primary studies will be contacted if there are missing data.

Key data extraction will include: study citation details, date of study, population, study purpose, study design, stated dietary assessment methodology, assessment tool(s), dietary components collected, details of tool, validity of tool, reported methodological limitations, nutrient database or food composition tables used to generate nutrition information, statistical analysis, associations between dietary exposures and health outcomes.

Presentation of results

Extracted data will be presented in diagrammatic or tabular form in a manner that aligns with the objective of the scoping review. Results will be organised under main conceptual categories that relate to the research questions, including year or period of publication, countries of origin, population, key attributes of the dietary assessment methods (including tools and calculation of nutrient intakes) and any reported limitations. Where applicable frequencies and summaries will be provided. A descriptive narrative that responds to the questions of the review will be included.

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Appendix 1: Initial search strategy

((((diet* OR nutrition OR "food intake" OR food OR drinks OR foodstuffs OR long term diet))) AND (("diet* assess*" OR "diet* survey" OR "diet* instrument" OR "diet* measure*"))) AND (("Cook Islands" OR "Federated States of Micronesia" OR Fiji OR "French Polynesia" OR Guam OR Kiribati OR "Mariana Islands" OR "Marshall Islands" OR Nauru OR "New Caledonia" OR Niue OR Palau OR "Papua New Guinea" OR "Pitcairn Islands" OR Samoa OR "Solomon Islands" OR Tokelau OR Tonga OR Tuvalu OR Vanuatu OR Wallis OR Futuna)) AND English[lang]

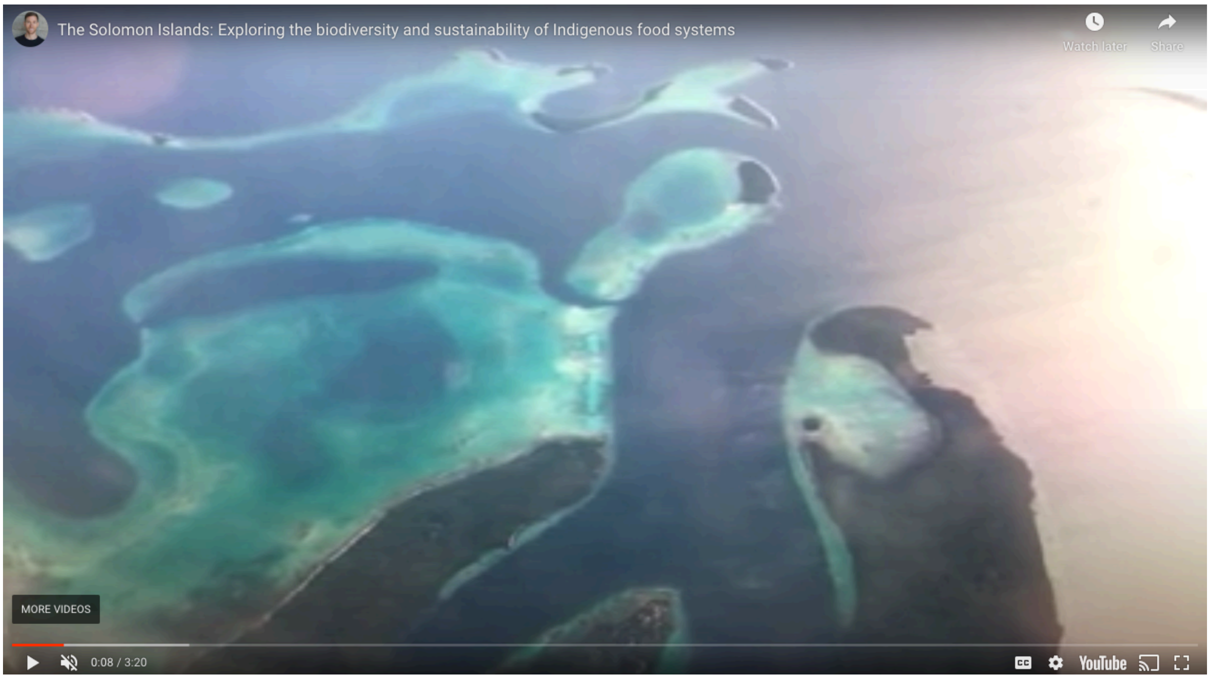
Appendix 2: Draft Data Charting Table

Study Details and Characteristics	
Study citation:	
Country:	
Date and duration of study:	
Study design:	
Study aim:	
Population:	
Dietary assessment method(s):	
Dietary assessment tool(s):	
Details of tool administration:	
Tool Validity (if reported, e.g. modified version or developed specifically for the study):	
Dietary components assessed (e.g. micronutrients, dietary patterns, food group intakes, etc.):	
Statistical analysis of reported data:	
Nutritional information (food composition tables or databases used to generate nutrient estimates from dietary intake data):	
Dietary factors (exposures) and health characteristics (outcomes) investigated and analysed:	
Reported limitations:	
Key Findings:	

Appendix J: Multimedia content

The Candidate won second place for the Future Leader Award award hosted by The Royal Society Te Apārangi focused on Solomon Islands food systems. This video also debuted at the 2018 UN FAO Indigenous People's forum in Rome, Italy.

Link to website that hosts the video: https://forwardeating.org/travels/the-solomon-islands/



Candidate also won the "best oral presentation award" at the Nutrition Society of New Zealand's annual symposium. Link: http://www.nutritionsociety.ac.nz/

Appendix K: Copyrights

Chapter 2: Statement of Contribution

DRC 16

MASSEY UNIVERSITY
GRADUATE RESEARCH SCHOOL

STATEMENT OF CONTRIBUTION
DOCTORATE WITH PUBLICATIONS/MANUSCRIPTS

We, the candidate and the candidate's Primary Supervisor, certify that all co-authors have consented to their work being included in the thesis and they have accepted the candidate's contribution as indicated below in the *Statement of Originality*.

Name of candidate:	Chris Vogliano
Name/title of Primary Supervisor:	Prof Jane Coad
Name of Research Output and full reference:	
Vogliano, C., Murray, L., Coad, J., Wham, C., Maelaua, J., Kafa, R., & Burlingame, B. (2021). Progress towards SDG 2: Zero hunger in melanesia–A state of data scoping review. Global Food Security, 29, 100519.	
In which Chapter is the Manuscript /Published work:	2
Please indicate:	
• The percentage of the manuscript/Published Work that was contributed by the candidate:	75
and	
• Describe the contribution that the candidate has made to the Manuscript/Published Work:	
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City: Tallmadge
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Country: United States
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Email: chrisvogliano@gmail.com

Type of Publication: Journal

Title: Progress towards SDG 2: Zero hunger in melanesia – A state of data scoping review
Auhtors: Chris Vogliano, Linda Murray, Jane Coad, Carol Wham, Josephine Maelaua, Rosemary Kafa, Barbara Burlingame,
Year: 2021
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Candidate's Signature:	
Date:	24 July 2021
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Anne

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Chris

Chris Vogliano MS, RDN

Technical Advisor, Food Systems - USAID Advancing Nutrition

Co-founder of Food + Planet

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Author: Chris Vogliano et al
Publication: Food Security
Publisher: Springer Nature
Date: May 10, 2021

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>
> Thank you!
>
> Best,
> Chris
> ---
> **Chris Vogliano MS, RDN**
> Technical Advisor, Food Systems - USAID Advancing Nutrition
> Co-founder of Food + Planet
> LinkedIN | Twitter

--
Tim Gasser
Communications & Marketing Assistant, MDPI
St. Alban-Anlage 66, 4052 Basel, Switzerland
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Haynes, E., Brown, C. R., Wou, C., Vogliano, C., Guell, C., Unwin, N. (2018). Health and other impacts of community food production in Small Island Developing States: a systematic scoping review. Revista panamericana de salud publica (Pan American Journal of Public Health), 42, e176.	
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Book: Advances in Food Security and Sustainability

Authors: Barbara Burlingame, Christopher Vogliano, Paul Eze Eme

Publisher: Elsevier

Date: Jan 1, 2019

Order Summary

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Appendix L: Method Guidebook of Chapter 3

Bioversity International-FAO Indigenous Food Systems Initiative

Method Guidebook

A participatory approach to characterize and assess resilience of Indigenous Food Systems to strengthen local capacities and inform Global debates on sustainability

Prepared by the Task Force under the lead of Gennifer Meldrum, Jessica Raneri, Rose Robitaille, and Gaia Lochetti with contributions from Edmond Dounias, Yon Fernandez de Larrinoa, Stefano Padulosi, Anne Brunel, and Valeria Poggi.

Under the advice of: Phrang Roy, Florence Tartanac, Guido Agostinucci, Dunja Mijatovic, Danny Hunter, Elisa Di Stefano, Annelie Bernhart, Marta Gruca, Emilie Vandecaldelaere, Carlos Lira, Nina Lauridsen, Nicole Franz, Divine Njie, Juan Gracia Cebolla, Festus Akinnifesi, Benjamin Davis, Jamie Morrison, Ahmed Shukri, Maya Takagi, Liseth Escobar Aucu, Rosalaura Romeo, Fabio Parisi, Gregorio Velasco Gil, Natasha Maru, and Esther Akwii.

Introduction

This document outlines a rapid, participatory approach to characterize and assess the resilience of Indigenous Food Systems. The main aim of the method is to document the inputs and outputs of the food system, links to the market, and indigenous practices and knowledge that support resilience and sustainability. The questions and methodology for the thematic discussions were defined by drawing on existing, piloted tools that were identified in a review as most suitable to the needs of the current study. The methodology was designed such that each day of discussion provides rich learning and take-home messages for the participants that is generated through exchanges of knowledge across generations and between the community and participating researchers.

A series of thematic discussions

Following an opening meeting to present the initiative and seek approval of the community to participate, this methodology for food system profiling is implemented through a series of seven thematic discussions with community representatives. Each thematic discussion concentrates on a specific aspect of the food system as described in Table 1. A closing meeting at the end of the project shares back the findings of the study and highlights strengths and weaker areas for sustainability and resilience for discussion.

Table 1. Topics and timeline for the thematic discussions

#	**Topic**	**Participants**
Opening meeting	Introduction to the initiative	Open invitation to full community
TD1	Traditions and trends in the food system	Group n.1 men of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60) Group n2. women of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)
TD2	Sustainable natural resources use	
TD3	Exchange, trade and marketing	
TD4	Seasons, climate shocks and change	
TD5	Food system institutions and governance	
TD6	Diversity in the diet and production system	
TD7	Young people's knowledge and perceptions	Group n.1 1 8-10 participants aged 7-12 mixed genders (children) Group n.2 8-10 participants aged 13-15 mixed genders (youth)
Closing meeting	Food system sustainability, climate change resilience, adaptation, and the future	Open invitation to full community

Community members - elders, women, men and children –each have their own perception of the food system and often play different roles and have different responsibilities and associated knowledge. For instance, children and youth often hold specific knowledge and eat different products compared to adults and elders are generally vital custodians of traditional knowledge. To include all the voices and perspectives in the community, separate groups for women and men of different ages (ranging from young adults to elders) are recommended to be convened for six of the thematic discussions. A special discussion and approaches is indicated for children and youth in the seventh thematic discussion. The discussions with children and youth could be held in association with the relevant thematic discussion or they can be combined into one dedicated discussion. Different community members should be invited to the different thematic discussions to encourage a high level of participation and representation of many voices. All of community members should be invited to the opening and closing meetings.

The discussions will be held in the period from April to until end of August 2018. Preferably the discussions would not take place on consecutive days to give time to both participants and facilitators to reflect and to build confidence and ownership of the initiative. A period of two weeks between each discussion is recommended. Each thematic group discussion is expected to take approximately six hours, although participants should expect to spend the full day for the exercise including travel time and breaks. The discussions for children and youth should be a maximum half day. The schedule for the thematic discussions should be defined by prioritising the preference and availability for the community.

Facilitation and logistics

This methodology is designed to be implemented by local indigenous organisations and research organisations that have strong relations with the selected indigenous communities and a good understanding of their food systems as described in **Annex 1**. The Task Force will accompany the implementation of this methodology and will provide technical assistance and monitoring as required.

Facilitation instructions

The content of the thematic discussions is described in the following sections of this document.

The methodology is written for the facilitators as the main user.

The questions should be translated and reworded as necessary to convey the concepts in a way that is understandable for the participants.

Specific syntax is used to distinguish the questions to be directed to the community, leading questions to support the discussion for the main question, and guidance for facilitation, as below:

Scripts and explanations for the community about the exercise are indicated with normal text.

(?) Questions to be directed to the participating community members are indicated by a question mark?

Leading questions, which may be used to prompt discussion for the main question are indicated by bullets. The facilitator can use these questions to stimulate discussion if the answer to the main question is not coming easily, or if the discussion has not sufficiently covered the topic of the bullet.

Facilitation and notetaking instructions, such as items to write on papers, cards or maps are indicated in blue italics. These instructions are not intended to be read to the participants.

The sections highlighted in yellow need to be prepared during the research process. The research task force will provide further details for these sections prior to implementation.

The results of the thematic discussions will be documented in the forms provided in **Annex 2**.

Facilitator

The facilitator has an essential role in running the workshop and making sure that all to topics are covered. S/he is responsible for communicating the purpose of the assessment and making sure all steps (e.g. introduction) are taken in the right order. S/he should have previous experience working with the indigenous communities identified, and conducting thematic group discussions. S/he needs to ensure that all participants are equally included in the workshop; and encourage active and meaningful engagement of the participants. The facilitator must direct the discussion without being a part of it. The facilitator must be able to create a relaxed, informal atmosphere where people feel free to express their opinions. The facilitator should never express his or her own opinions or make judgments on the opinions of the participants. According to the social and cultural context the facilitator may use different facilitation methods to encourage participation and energisers. (E.g. http://www.pyeglobal.org/wpcontent/uploads/2011/11/CreativeFacilitationManual.pdf).

Responsibilities

Icebreaker: The facilitator is free to decide the kind of icebreaker that they are experienced with. An example can be to simply ask each participant to stand and state their name, age and occupation

Introduce the group to the project, explain how the information will be used and they are welcome to participate at their own free will.

Ensure no one takes over or dominates the discussion.

Encourage discussion and debate amongst the group

Ensure that each person can participate and express their opinion; if there is a dominant person try to moderate the discussion to involve others

There are no 'wrong' answers. If something seems improbable, ask the participants to explain and/or confirm

Encourage consensus building, while acknowledging and welcoming multiple viewpoints

Do not lead responses

Ensure that the roles of men, elders, women and children in the food system are well shared throughout the thematic group discussions.

Ensure date, village and component title are documented on all materials

Encourage participants to write and produce the materials during the workshops – however if this is not possible, assist.

NoteTaker

Taking notes is very important for capturing the major points and explanations raised in the discussions that may not be captured on the papers and documentation produced by the group. It is important to take notes during the entire workshop, including the introduction. The notes are the material for the narrative of the report. Data forms for how the information will be documented are provided in **Annex 2**.

Each thematic group discussion is expected to take around 6 hours not including breaks. Notetakers should pay attention to the estimated times indicated for each section of thematic discussions to help the facilitator with time management. Providing hand signals or other gestures can be effective ways to indicate the approximate time left for each section to ensure that all questions are covered, notetakers should take care to not interrupt the participants or the facilitator if possible. Methods for keeping time should be agreed upon before all discussions

Responsibilities

Record name, age, gender, village/community, and occupation of each participant

Take photos of flipcharts, participatory map and layers, mobility map any relevant output created during the thematic group discussions.

Take photos of the participants during the thematic group discussions or eventually in the landscape, should they agree.

If any and should the participants agree, document the food system with photos, video and other media capturing:

Agrobiodiversity available in the landscape at different time of the year, production and natural resource management practices, disappearing species, traditional food preparations, sings and myths that are culturally important for the community

Products bought and sold in the markets

Wild species, cultivated species, animals, and any activity related to food, production and its by-products

Any other relevant activity characterizing the food systems

The participants can decide to withhold sharing any kind of information captured by any kind of media.

Record as much information as you can, including discussion and debates by the participants. Document consensus answers as well as competing viewpoints when they arise

If you notice that information is not complete or addressed adequately, notify the facilitator.

If you require confirmation or clarification on something, ask the facilitator to reconfirm with the group.

At the end of each discussion, the documenter should be able to provide:

1.	The name, age, gender, village/community and occupation of each participant for the opening meeting, each thematic group discussion, and the closing meeting
2.	The completed data collection forms in Annex 2 for each thematic group discussion
3.	Flipchart sheets and photos from each discussion
4.	Satellite map with the boundaries of the community and layers produced during the thematic discussions

Translator

If the facilitator and the notetaker don't speak the local language, you will need a translator. The translator will translate the thematic group discussion into local language and translate the questions, answers and discussion during the assessment.

Refreshments

Prepare suitable refreshments (water, tea, cookies) and organise meals for participants. Refreshments and lunch for the entire group need to be organised in advance, for example with volunteer members of the community. Money for the food and other workshop costs (e.g. transport to the venue) comes out of the fieldwork budget.

Going deeper with optional exercises

In addition to the basic exercises that will be completed by all communities participating in the initiative, some optional exercises could be followed to go deeper on related topics, gain insights, find solutions, and generate products of interest to the community. Some proposed optional exercises are described in **Annex 2**, while additional exercises may be proposed by the community and local partners based on local priorities. Existing data and previous studies on the food system that can elaborate and provide further detail on the topics covered in the assessment are encouraged to be leveraged in the analysis and reports.

Analysis and reporting

The results of the thematic discussions will be documented in template forms as provided in **Annex 2**. In **Annex 2** the notetaker and facilitator will find forms and specific directions for notetakers to guide data collection throughout the Bioversity International-FAO Indigenous Food Systems Project. Forms presented throughout the *Method Guidebook* are intended to help the facilitator record information during focus group discussions.

The food system profile will summarize the inputs and outputs of the indigenous food system and the factors that influence and are influenced by the system in terms of food production and distribution, human health and wellbeing, and environmental impacts. The profile will follow the topology of food systems presented by Chase and Grubinger 2014, while considering the unique biocultural interactions and unique elements of traditional knowledge. The food system will be evaluated considering the five principles of sustainability in food agriculture (FAO 2014):

Efficiency in the use of resources

Direct action to conserve, protect and enhance natural resources

Protection and improvement of rural livelihoods, equity and social well-being

Resilience of people, communities, and ecosystems

Responsible and effective governance systems

The assessment of climate resilience will be made through the lens of the indicators proposed in the method of self-evaluation and holistic assessment of climate resilience of farmers and pastoralists (SHARP; FAO 2017):

Socially self-organized

Appropriately connected

Optimally redundant

Exposed to disturbance

Coupled with local natural capital

Reflective and shared learning

Globally autonomous and locally interdependent

Honours legacy

Builds human capital

Reasonably profitable

While referring to the SHARP indicators in the analysis, the method of collecting the information for the resilience assessment will follow a different style and will incorporate the indicators and style of the social-ecological resilience to climate change (Bergamini et al 2014). This approach will allow results of the resilience assessment to be presented back for discussion with the community during the closing meeting. Results will then be further analysed through the SHARP for reporting and presentation at the seminar at FAO in late 2018. The analysis guide is under development and will be shared later in the implementation.

Sources

This methodology was prepared drawing inspiration from numerous sources, especially:

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Bergamini et al. (2014) Toolkit for the Indicators of Resilience in Socio-ecological Production Landscapes and Seascapes. UNU-IAS; Bioversity International, Rome (Italy); IGES; UNDP

Berkes, F., Colding, J., and Folke, C. (2000) Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications 10(5):1251-1262

Brimblecombe et al. (2014) Good Food Systems Overview: Information Sheet. Menzies School of Health Research in Darwin, Australia.

Chase, L. and Grubinger, V. (2014) Introduction to Food Systems. IN Food, Farms and Community: Exploring Food Systems. University Press of New England

FAO (2014) Building a common vision for sustainable food and agriculture: Principles and approaches. Rome, Italy

FAO (2016) Voices of the hungry: Measuring food insecurity through people's experiences: One metric for the world.

FAO (2017) Self-evaluation and holistic assessment of climate resilience of farmers and pastoralists (SHARP). Rome, Italy.

FAO and FHI 360. (2016). Minimum Dietary Diversity for Women: A Guide for Measurement. Rome: FAO.

Roué and Molnàr (2017) Knowing our lands and resources: Indigenous and local knowledge of biodiversity and ecosystem services in Europe and Central Asia. Knowledges of Nature 9. UNESCO. Paris.

Opening meeting: Introduction to the Initiative

Objectives

The intention of this first meeting is to formally open the activities of the initiative. The objectives will be presented and the topics of the discussions that will be carried will be shared. The main interests and objectives of the community will be discussed to understand how the study can be implemented to best meet their needs. Feedback will be gathered on the timeline for the discussions.

Participants

Community leaders

Open invitation to all community members, ensuring gender and age representation

If manageable within timeline, representative/s of the research task force

Outline of the session

Introduction to scope and objectives

Key definitions: what is a food system?

Key definitions: what is climate resilience?

Proposed thematic discussions

Expected outcomes

Optional exercises

Consent of the community to join the initiative

What does the community want to achieve with this study?

Conclusions

Materials

Brief handout on the supporting organizations or the updated concept note

Introduction to scope and objectives

Greetings and introductions. Round table introductions or other suitable icebreaker.

We are here today to present and request your participation in an initiative of Bioversity International, FAO, the French National Research Institute for Sustainable Development (IRD), the Indigenous Partnership for Agrobiodiversity and Food Sovereignty (TIP), and the Centre for International Forestry Research (CIFOR). These organizations are united by the belief that the voice of indigenous communities is crucial yet underrepresented in the global conversation about sustainable food systems and climate change resilience. Indigenous communities have deep wisdom and connection to the earth. For many generations communities have used traditional knowledge to protect local resources while providing a variety of local healthy foods and livelihoods. However, currently markets, social and climate changes are creating new and unprecedented challenges for indigenous food systems to meet current needs, leading to loss of traditional knowledge and practices.

To address these concerns, a meeting was held in 2015 at FAO with indigenous peoples' representatives from groups all over the world, including indigenous farmers, traditional keepers of knowledge, members of the United Nations Permanent Forum on Indigenous Issues (UNPFII), community members, political leaders, and technical experts. Through this gathering, it was found that the collaboration with indigenous peoples and the understanding of the specificities and diversity of each country needs to be strengthened. This initiative follows on these recommendations.

Indigenous communities in at least five regions of the world are joining in this initiative to document their food systems and characterize their practices that enable sustainability and climate resilience. The results from each community will be presented at an international seminar at FAO in late 2018, which will be an opportunity to share experiences, connect, and learn from one another. Your community is recognized as having strong traditional knowledge and connection to your cultural practices. It will be an honour if your community would join this initiative.

Through this initiative we would like to invite your community to share ideas about your food system, sustainability, and climate resilience. Together we would work to characterize the perspectives, experiences, cultural realities and threats to your communities and food systems. Information collected as part of the process can be used by the community to increase control and influence over decisions and inform policy and practice to improve people's access to a sustainable and climate resilient food system.

What is a food system?

Describe to the community what a food system is and why it is of interest.

The focus of the study will be on the indigenous food system. Communities whose subsistence and livelihoods are still strongly linked to natural resources have developed food systems through generations with close ties to their local environment. The foods that are produced and eaten in the community will be a main focus of the discussions, as well as local practices, values, and institutions that influence what is produced and consumed.

The food system is dynamic and always changing. Cultural shifts, development of infrastructure and services, and also changing weather conditions are affecting the foods that people eat and the practices people follow for production. A focus of the initiative will be to understand the changes that are happening and how they are affecting the sustainability and resilience of the food system.

Ask the community to reflect on their own food system

(?) How would you describe your food system?

(?) What are your community's most important food sources?

(?) Do these food sources change throughout the year?

(?) Are there foods or practices for producing or obtaining food that are unique to your community?

(?) What challenges does your community face in trying to access food throughout the year?

(?) How dependent is your food system on people or businesses outside of your community?

(?) What relations you have with people out of your community that are beneficial to your food system?

(?) What relations you have with people out of your community that are threatening to your food system?

What is climate resilience?

Describe to the community what a climate resilience is and why it is of interest.

Communities and the ecosystems they live in experience various pressures and disturbances such as drought, floods, storms, and pest and disease outbreaks. Communities' ability to absorb or recover from these pressures and disturbances–in terms of both ecosystem processes and socio-economic activity–without lasting damage is what is referred to as "resilience". More generally, resilience refers to the "capacity of a system to deal with change and continue to develop; withstanding shocks and disturbances and using such events to catalyse renewal and innovation". Social institutions and the presence of key local resources are some important factors that enable recovery to shocks. This study will look into the resilience elements of the community to highlight the strengths and also areas of resilience that could be improved through specific actions.

Communities around the world are experiencing changes in the climate and especially increasing incidence of climate shocks like drought, floods, and storms. Strategies for coping with such shocks are typically embedded in traditional knowledge and practices and new practices and approaches may be being developed by the community to adapt. The initiative will explore the changes that are being experienced by the community and how you are adapting, which can stimulate interesting knowledge sharing across generations regarding resources and approaches that can support adaptation.

Proposed thematic discussions

In this initiative we will explore the food system through a series of discussions focused on a specific aspects of the food system. Elements of food system resilience will be discussed in each session and will contribute to a system assessment of resilience that can inform community actions to strengthen and advocate for support The discussions will cover:

Traditions and trends in the local food system

Sustainable natural resources use

Exchange, trade and marketing

Climate shocks, seasons and change

Food system institutions and governance

Diversity in the diet and production system

Young people's knowledge and perceptions

Each discussion will require about 5-6 hours. They will include some exercises drawing and writing, and sharing back the results of break out groups. We would also take some time to eat together, so we would plan for each discussion to involve the whole day. Discussions with children and youth should not be longer than half a day.

In order to ensure thorough inclusion of men and women's unique knowledge in the assessment, we will hold each discussion with men and women in different groups. The groups should include a mix of age groups, from young adults to elders to allow a sharing of knowledge across generations. Special discussions will be held with children and youth to allow them to share their unique perspective on the food system. Ideally, for each thematic discussion, different people will have the chance to participate. The closing session will be a devolution and will involve community representatives and any other members of the community willing to acknowledge on the results of the thematic discussions. The discussions should take place between April and August.

Expected Outcomes

The expected outcomes of the initiative that will be achieved through the different discussions are:

Enhanced local understandings of your local indigenous food system

Highlighting unique characteristics and traditional practices

Providing resilience indicators to prioritize threats and challenges to your community

Creating a space for collaborative knowledge sharing and learning on different aspects of the food system

Enhanced networks and communication

Participation or representation of your community in an international seminar at FAO in late 2018

Exchanging ideas about food systems, sustainability, traditional knowledge, and climate resilience with other participating indigenous communities around the world.

Optional exercises

In addition to the thematic discussions that are proposed for this initiative, which will be carried out by all the communities participating in the initiative, some additional optional exercises can also be completed to go deeper on certain topics and generate some products for the community to document, and strengthen knowledge sharing about the local traditions and practices. Some activities that may be of interest include producing a community biodiversity register, traditional knowledge register, local cookbook, or seasonal availability calendar of fruits. Additional topics or activities may be proposed by the community.

*Should it be of the interest of the community, the optional exercises are presented in **Annex 3** for more information.*

Consent of the community to join the initiative

The initiative will follow the principles of Free, Prior and Informed Consent (FPIC), ensuring the participation of the community members, the sharing of information and consent on the work to be undertaken. The consent should be given to the facilitator as per the traditions and customary law and practices of the community.

What does the community want from this initiative?

Through this section, the facilitator will engage the community in a discussion to understand what the outputs that they expect out of this initiative are. Some guiding questions are provided below.

We would like to seek some feedback from the community on how they perceive the project.

(?) What would your community like to get out of participation in this study? What are the expected benefits?

(?) Does the community see any risks or negative impacts of participation? How could those negative impacts be avoided or resolved?

(?) Are there any aspects the community would modify about the study*? If the community disagrees to some elements, try to understand why. If it is regarding the approach for data collection, try to discuss some alternative approaches and conclude that we will reflect and propose some alternate approaches that can be discussed later for agreement. If it is regarding the collection of the information in general, then we must conclude that the community is not willing to participate.*

(?) Are there any aspects the community is interested to add to the study what would you like to share about your practices, are there any topics that you would like to explore with your community in more detail? *Collect suggestions and conclude that we will explore the feasibility within the project resources to add these elements/topic of study.*

Propose a schedule of the discussions for the approval of the community

Conclusions

We are very pleased that your community will be joining in this initiative this year to learn, share and discuss together with the global network of indigenous communities and advocates engaged in this effort. Over the coming months, we look forward to engaging with you in discussions about different aspects of your local food system in order to highlight its strengths and identify strengths of your local biodiversity, knowledge and practices that can enhance local diets, market connectivity, and resilience in your community and can be an example for other communities around the world.

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Ask for feedback

Round of thanks

Preliminary key informant interview/s

Objective

The Key Informants Interview/s aim at gaining general background information on the community and defining the boundaries of the community landscape on a map so that satellite maps can be used during the thematic discussions. Some topics may not need to be addressed if the information is already known and documented by the research partner.

Participants

2-5 Community leaders, elders and representatives of mixed gender

If manageable within timeline, representative/s of the research task force

If a group discussion does not seem suitable, the topics can be addressed through one or more interviews that ensure to capture both male and female perspectives

Outline of the session

1. Orientation to the community (30 minutes)
2. Community structure and gender roles (30 minutes)
3. Taboos and comfort in addressing sensitive topics (15 minutes)
4. Boundaries of the community territory (45 minutes)
5. Participatory Mapping (45 minutes)

Materials

Paper, different colored markers, Google earth/Google maps with internet or offline functionality, otherwise physical maps of the area to cover different scales of relevance to the community, printed map, transparent paper (for layer 1 and layer 2)

Total estimated time: 3.45 hours

Discuss openly the questions in sections 1-3. Notetakers are to document the results of the following conversation in their notebook. For section 4 the notetaker should record notes on landscape features as necessary.

1. Orientation to the community (30 minutes)

To support the upcoming thematic discussions with community members, we would like to understand better the local community and how it is organized.

(1.1) Will there be one or more than one communities participating in this initiative? What is the name of the community (or communities) that will be participating?

(1.2) What is the population of the community?

(1.3) What is ethnicity of the community? Is there more than one ethnicity in the community? Is there more than one ethnicity in the region?

(1.4) What is the local language/s? What are the languages that will be best for communicating with the local people?

(1.5) Has the local language/s changed compared to the time of your parents/ grandparents? Why?

(1.6) Do young people learn their local language? Is local language taught in schools?

(1.7) What is the local religion? Is there more than one?

2. Community structure and gender roles (30 minutes)

(2.1) Who leads the community? Are there traditional leaders? Are there government leaders? Are they the same?

(2.2) How are decisions made in the community?

(2.3) How is the community organized? Who lives together? Who works together? Who eats together?

(2.4) What are the roles of men and women in the community – are they different?

Consider especially natural resource management, production, hunting/gathering activities, by-product generation, transformation of food, selling of purchasing food, preparing meals

(2.5) Are there special roles for elders in the community?

(2.6) What are the roles of children and youth?

(2.7) At what age do women and men marry?

3. Taboos and comfort in addressing sensitive topics (15 minutes)

Review the topics of the discussions and ensure that all topics will be comfortable to address in a group setting.

(3.1) Are there particular taboos or sensitive topics we should avoid discussing with the community or that should be discussed in a more sensitive way?

(3.2) Are there some foods that the community do not consume because of religious or cultural beliefs that would be offensive or rude to ask about?

4. Community territory (2 hours)

In the thematic discussions we will be taking a landscape-focused approach in which different features and areas will be discussed for how they relate to natural resource management, food production, hunting/gathering, by-products generation, purchase and trade, as well climate regulation.

Today we would like to identify the main features of your community landscape to support interpretation and the documentation of the food system study.

Exercise: Mapping

Complete the following exercise using printed maps with different scales that cover the local landscape.

(4.1) What are the limits of the community? What is the area that is relevant to local livelihoods (i.e. how far do people go to collect water, foods, visit markets, work, etc.)? What are the different scales that would be relevant to print to support the thematic discussions?

(4.2) Where are the buildings and houses of the community?

This step will help everyone to recognize and locate themselves on the map. Make sure you spend enough time doing this, since good results depend on communities' recognition of their landscape. Make sure you assess, clarify and apply the scale and orientation concepts.

(4.3) Where are forests, natural areas, wetlands?

(4.4) Where are the cropping fields? Are there different fields used for different crops?

(4.5) Where are orchards and planted trees in the landscape?

(4.6) Where are the home-gardens located?

(4.7) Where are beehives kept? Or other important production-related structures (e.g. mushroom or insect raising, aquaculture)?

(4.8) Where are areas where livestock are grazed?

(4.9) Where are areas where wild foods, medicinal plants and plants for other uses such as green manure, fodder and composting materials are collected?
(4.10) Where are areas where community members fish?

(4.11) Where are areas where community members hunt?

(4.12) Where are the communal water sources, which ones (if any) are for drinking water?

(4.13) What are other important uses of the landscape?

(4.14) Mark the areas that are privately owned, communally owned, government owned. Are there any areas where ownership is disputed?
(4.15) Mark the protected areas of the landscape. How are they protected (customary laws or formal protection mechanisms)?
(4.16) Mark the fences in the landscape? What is their purpose?

(4.17) Mark the sacred areas

Take a picture

***

Ask feedback

Round of thanks

Thematic Discussion 1: Traditions and trends in the local food system

Objective

This discussion explores how local diets and the production and sourcing of food from the local landscape are changing over time. The value, transmission, and documentation of traditional knowledge are assessed in relation to changes in the local food system overtime. By assessing trends, the participants can project how the local food system might look in the future. This discussion concludes with a self-assessment for key resilience indicators of the local food system and transmission of traditional knowledge, and the mapping of key points relating to the day's discussion.

Participants

group n.1	Men	10-15 men of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)
group n.2	Women	10-15 women of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)

Outline of the session

1. Community timeline (2 hours)

2. Sufficiency (1 hour)

3. Food Traditions (1 hour)

4. Maintenance and transmission of traditional knowledge (45 minutes)

5. Future projections for the local food system (30 minutes)

6. Resilience elements (45 minutes)

Total estimated time: 6 hours

Start with an icebreaker and documentation of the group participants. Communicate the expected programme and timing of breaks during the day.

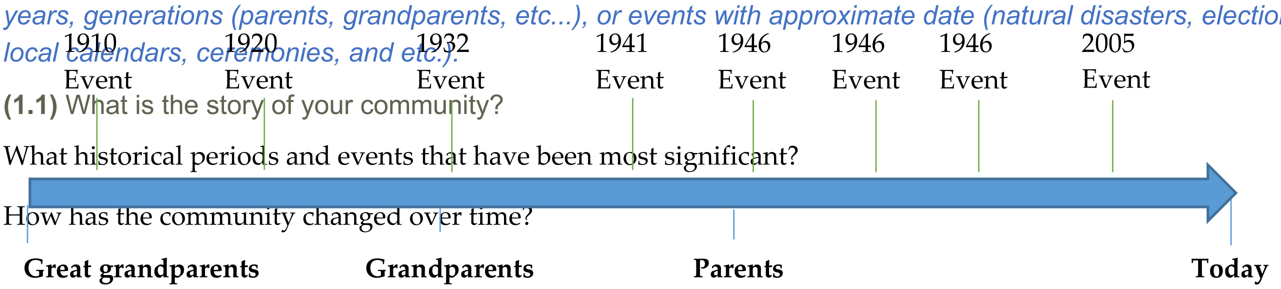
1. Community timeline (2 hours)

Draw an arrow to represent a timeline many on many large pieces of paper, whiteboard, chalkboard, or other available materials. Document the answers for this section on the timeline. If it gets too crowded, a new timeline can be started for different topics. Indicate the events and changes on the community timeline using approximate years, generations (parents, grandparents, etc...), or events with approximate date (natural disasters, elections, local calendars, ceremonies, and etc.).

(1.1) What is the story of your community?

What historical periods and events that have been most significant?

How has the community changed over time?



(1.2) What was the reasons for the changes when the community has gone through major transitions? *Indicate the reasons on the timeline if possible.*

(1.3) How have the livelihood activities of the community changed over time (e.g. livestock raising, cultivation, off farm employment, etc.)? Why? *Indicate the changes on the community timeline.*

(1.4) How have the foods eaten by the community changed over time? When and why did changes occur? *Indicate all the changes in the diet on the community timeline.*

Have diets changed compared to the time of your parents? And to the time of your grandparents? What changes have taken place? Why?

Have any foods been introduced to the community? When, why and from where?

Have any foods that used to be consumed by the community disappeared or nearly disappeared? If yes, when and what is reason?

(1.5) Have the foods produced and sourced from the wild by the community changed over time?

When and why have changes occurred? *Indicate the changes on the community timeline.*

Have the foods produced, collected, hunted and fished from the landscape changed compared to the time of your parents? And to the time of your grandparents? If so, why?

Have food plants or animals disappeared from the wild or gone locally extinct? Which ones, when, and why?

Have new food plants or animals appeared in the landscape that are being used for food? Which ones, when and why?

Are some wild plants and animals more recently used for food that were not before? Which ones, when and why?

Have crop species/varieties or livestock species/breeds been abandoned or no longer produced by the community? Which ones, when, and why?

Have crop species/varieties or livestock species/breeds been introduced? Which ones, when, and why?

(1.6) Have the sources of feed and forage for livestock changed over time? How? When and Why? *Indicate the changes on the community timeline.*

(1.7) Has the use of animal and plant products from the landscape for construction, containers, clothing, medicine, energy, and cosmetics changed over time? What has changed, when and why? *Indicate on the community timeline.*

(1.8) How has the landscape changed over time? When and why did these changes in the landscape occurred? *Indicate on the community timeline.*

Have some areas been converted from forest to cropland?

Have some areas been reforested? Have trees been planted?

Have water bodies and water sources changed?

What other major changes have occurred in land use over time?

2. Sufficiency (1 Hour)

Draw a chart with the following headings on a piece of paper and document the answers from this section in the associated section on the table.

(2.1) Has there been a change in the [*element*] in the community compared to the past? What changes have been observed? When? Why? *Discuss and fill the table element by element.*

Element	Change compared to past (more, less, same)	When change occurred and reasons
Amount of food eaten/sufficiency of food supply		
Nutrition and health of local people		
Amount of food sourced from the wild (collected, hunted or fished)		
Amount of food produced by the community (farming, livestock raising etc.)		
Adequacy or quality of forage		
Self-sufficiency of the community		

3. Food traditions (1 Hour)

For question 3.1-3.2 free list the traditional foods and drinks on the blank piece of paper labelled 'Traditional foods'.

(3.1) What are the traditional foods and drinks of the community?

(3.2) What is the balance of traditional and non-traditional foods in diets today (estimate %)? *Write the number on a piece of paper along with names of the foods if mentioned.*

How often are traditional foods eaten?

Are they eaten in large portions?

For question 3.3 discuss and record the answer in the notes.

(3.3) Would people like to eat more traditional foods?

Do people like the taste of traditional foods?

Are any challenges experienced with eating traditional foods?

For question 3.4-3.5 free list and write the answers on a blank piece of paper labelled 'Traditional crops, animals and forage sources'.

(3.4) What are the traditional crops/varieties, livestock/breeds, and forage sources?

(3.5) What proportion of crop and animal production is under traditional species/varieties as compared to introduced ones (estimate %)? *Write the number on a piece of paper along with names of the foods if mentioned.*

Are they maintained in large areas or numbers?

For question 3.6 discuss and record the answer in the notes.

(3.6) Would community members like to use more of their traditional crops/varieties, livestock/breeds, and forage sources?

Are any challenges experienced with maintaining traditional crops and animals?

4. Maintenance and transmission of traditional knowledge (1 hour)

Discuss openly the questions 4.1-4.4. Notetakers are to document the results of the following conversation in their notebook.

(4.1) Do community members want to maintain their traditions related to their local food system (production, collecting, sale and consumption of foods) into the future? Why?

(4.2) Are some food system related traditions at risk of being lost to future generations? Why?

Do children through to elders know the names of plants and animals?

Do they know how to obtain, process and prepare them?

(4.3) How is knowledge related to the traditional food system communicated and passed down in the community?

Are elders respected and supported to pass on their knowledge to younger people?

Are there skilled hunters, collectors, farmers, and/or herders in the community?

Is there support for people to spend time in traditional food activities (e.g. hunting, fishing, farming, cooking, preparing foods, etc.)?

How is knowledge of traditional foods passed on to younger generations in the community? If not, how are the younger generation expected to learn these traditions.

(4.4) How has passing on traditional knowledge of the food system changed over time?

5. Future projections (30 minutes)

On a blank piece of paper, prepare a table with four columns and the headings "Landscape", "Production", "Wild sourcing" and Diets".

(5.1) How do you think the landscape of the community will look in the future? What will be the major land uses? *Document the ideas about major land uses in the 'Landscape' column*

(5.2) How will the production of crops and livestock in the community change in the future? *Add the ideas about future production in the "Production" column.*

What foods will be produced by the community 20 years?

Will the use of traditional crops and animals increase or decrease in the future? Why/why not?

(5.3) How will collection, hunting and fishing from the landscape change in the future? *Add the ideas about future production in the "Wild sourcing" column.*

Landscape	*Production*	*Wild sourcing*	*Diets*

Prepare a large paper for questions 5.4-5.5 with the heading "Future changes and free list projections for the diet 20 years in the future.

(5.4) How do you think diets in the community will change in the future? What foods will be eaten in 20 years' time?

Which foods will be eaten more often or in bigger quantities? Will these foods be locally produced or imported from outside?

Which ones will be eaten less often or in smaller quantities? Why? Will these foods be locally produced or imported from outside?

Will consumption of traditional foods increase or decrease in the future? Why or why not?

How much of the diet will be collected, hunted or fished from the landscape? How much will be farmed? How much will be purchased or traded in the market?

(5.5) What do you think the consequences of these changes in the landscape, production, wild sourcing and diets for the wellbeing of the community and the environment (nutrition, health, sustainability)?

6. Resilience elements (1 hour)

Throughout this series of thematic discussions, we are making an assessment of elements in the food system that contribute to resilience, or the capacity for your community to deal with change and continue to develop; withstanding shocks and disturbances and using such events to catalyse renewal and innovation.

We would like to take a minute to reflect on the discussion today and discuss three indicators of resilience. For each, we would like you to reflect and provide a score for the community on a scale of 1 to 5 and indicate the trend for the indicator. First, everyone can score the indicator for themselves and then we can discuss and come to a consensus answer.

Start a blank piece of paper to document the results in a table with the headings: "indicator", "score", "trend", and "reasons". Add the names of the indicators and consensus scores, trends and reasons as the discussion progresses. Allow time for an open conversation about the implications and reasoning behind the perceptions of the participants.

Maintenance of local breeds and varieties

(6.1) Does the community maintain local breeds and varieties? *Discuss and decide on a consensus score: (5) Very high (high preservation of local breeds and varieties); (4) High; (3) Medium; (2) Low; (1) Very low (There are very few or no local breeds and varieties).*

(6.2) Is the use of local breeds and varieties increasing, decreasing, or remaining stable? *Discuss and decide on a consensus score*

(6.3) Why has this score and trend been assigned? *Document the reasons for the score and trend well in in the notes.*

Transmission of traditional knowledge

(6.4) Does the community have mechanisms in place to transmit traditional knowledge? *Discuss and decide on a consensus score: (5) Very high (high preservation of local breeds and varieties); (4) High; (3) Medium; (2) Low; (1) Very low (There are very few or no local breeds and varieties).*

(6.5) Is the transmission of traditional knowledge increasing, decreasing, or remaining stable? *Discuss and decide on a consensus score*

(6.6) Why has this score and trend been assigned? *Document the reasons for the score and trend well in in the notes.*

Documentation of traditional knowledge

(6.7) Does the community have mechanisms to document traditional knowledge? *Discuss and decide on a consensus score: (5) Very high (high preservation of local breeds and varieties); (4) High; (3) Medium; (2) Low; (1) Very low (There are very few or no local breeds and varieties).*

(6.8) Is the documentation of traditional knowledge increasing, decreasing, or remaining stable? *Discuss and decide on a consensus score*

(6.9) Why has this score and trend been assigned? *Document the reasons for the score and trend well in in the notes.*

***

Ask feedback

Round of thanks

Thematic Discussion 2: Sustainable natural resource use

Objective

This discussion will explore the communities' practices for sustainable natural resource use and how practices are changing over time. For this thematic discussion, the facilitator should allow narratives to emerge out of the different topics, while inviting the participants to describe their activities to their use of the natural resources.

Participants

group n.1	Men	10-15 men of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)
group n.2	Women	10-15 women of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)

Outline of the session

1. Wild resources (2 hour)
2. Soil (2 hour)
3. Water (2 hour)
4. Energy (2 hour)
5. Waste (1 hour)
6. Pest and disease regulation (1 hour)
7. Pollination (1 hour)
8. Resilience elements and conclusion (30 minutes)

Total estimated time: 6.5 hours

Start with an icebreaker and documentation of the group participants. Communicate the expected programme and timing of breaks during the day.

1. Wild resources (1 hour)

The following questions will explore local practices and rules (e.g. taboos and totems, customs and rituals, rules and regulations, protected areas) guiding the use of wild resources to ensure their continued availability into the future, as well as changes that are occurring in the availability of wild resources.

Prepare a blank paper for questions 1.1-1.3 with the headings in the table below. Discuss the following questions for each activity and document the answers in the table. If a topic has a lot of associated knowledge, then more papers can be used.

(1.1) Are there local practices and rules guiding [*activity*] to ensure continued availability of the resource into the future? What is the reason for the practice or rule?

(1.2) Are current practices and rules for [*activity*] different from the past? What are the traditional rules and practices for [*activity*]? What are the reasons for any changes in practice? *Ensure to document well the reasons for the rules and practices.*

(1.3) Do community members still use traditional sources and practices for [*activity*]? When are they used? *Add the answer in the first column of the table.*

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Hunting and trapping animals	*Examples such as:* *Description of activities followed* *When to hunt?* *How many animals to take?* *Which animals to select?.*	
Fishing		
Harvesting of wild plants or non-timber tree products (for food, medicine, fodder, etc.)		
Cutting of trees and collection of timber		
Grazing animals in natural areas	*Examples such as:* *Which land is used for grazing?* *When are animals grazed in natural areas? For how long?* *How many animals are allowed in different areas at different times?*	

For questions 1.4-1.5 document the answer in the notes for the following discussion.

(1.4) How is the availability of wild plants and animals being harvested, hunted, fished, and grazed? Are some species increasing or decreasing? Why? How is the community adapting to changes?

(1.5) Have community members been involved in domestication of wild plants or animals (including aquatic species)? Which species? How successful are these attempts?

2. Soil (2 hours)

The following questions will explore local practices for soil management to maintain and enhance soil quality and how soil quality is changing over time.

For questions 2.1-2.3 discuss and document the answers in the notes.

(2.1) How does the community characterize soils in their landscape?

(2.2) What signs do the community look for to identify good soil for cultivation?

(2.3) Do some areas of the landscape have better soil quality or different soil characteristics? What is the reason for the difference?

Prepare a blank paper for questions 2.4-2.7 with the headings in the table below. Considering the activities listed, one by one discuss and document in the table:

(2.4) What are local practices and rules for [*activity*]? What is the reason for the practice or rule?

(2.5) Are current practices and rules different from the past? What are the traditional rules and practices for [*activity*]?

(2.6) Do community members still use traditional practices and rules for [*activity*]? When are they mobilized?

(2.7) What are the effects of changes in rules and practice for [*activity*]?

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Maintaining and increasing soil fertility	*If the following topics do not come up in the discussion on their own, inquire whether they have current practices and rules related to:* *Rules and practices for fallowing land* *Use of natural or chemical fertilizers (specify which type used e.g. manure, compost, etc.)* *Use and integration of legumes in crop rotations and intercropping*	
Erosion control	*If the following topics do not come up in the discussion on their own, inquire whether they have current practices and rules related to:* *Maintaining soil cover with cover crops or mulches (specify which crops, location and rationale)* *Tilling soil*	
Adapting to different type of soil in the landscape	*If the following topics do not come up in the discussion on their own, inquire whether they have current practices and rules related to:* *identifying specific species for specific lands*	

For questions 2.8-2.9 document the answer in the notes for the following discussion.

(2.8) How is soil quality in the community today? Is it sufficient to meet the needs of the community?

(2.9) Is soil quality changing? Why? How is the community adapting to changes?

3. Water (2 hours)

The following questions will explore the water sources for different uses, local practices for ensuring adequate availability and quality of water throughout the year, and how water availability and quality is changing over time.

For questions 3.1-3.3 discuss and document the answers in the notes.

(3.1) What are the biggest water demands in the community (e.g. drinking water, irrigation)? Of the water used for irrigation do some crops or animals need more than others?

(3.2) Who in the community is responsible for collecting water? How far do community members usually have to travel to collect water? How do they travel to collect it? How long does it take people to go collect water and return home? How often do community members go to collect water?

(3.3) Do some areas of the landscape have better water availability? If so, what is the reason for the difference? *Prepare a blank paper for questions 3.4-3.7 with the headings in the table below. Considering the activities listed, one by one discuss:*

(3.4) What are current sources, practices and rules in the community for [*activity*]?

(3.5) Are current sources, practices and rules different from the past? What are the traditional water sources, rules and practices for [*activity*]?

(3.6) Do community members still use traditional sources and practices for [*activity*]? When are they mobilized?

(3.7) What are the effects of changes in practice for [*activity*]?

Activity	Current sources, practices and rules, reasons, and when adopted	Traditional sources, practices and rules, reasons, and when adopted
Ensuring adequate quantity and quality of drinking water	*If the following topics do not come up in the discussion on their own, inquire whether they have current practices and rules related to:* *Water storage* *Purification practices* *Actions to protect water sources from contamination* *Practices for locating water sources* *Practices to adapt to heterogeneous availability and quality of water (e.g. migration)*	
Ensuring adequate quantity and quality of water for household use (cooking, hygiene, etc.)		
Ensuring adequate quantity and quality of animal drinking sources		
Ensuring adequate quantity and quality of water for cultivation and irrigation.	*If the following topics do not come up in the discussion on their own, inquire whether they have current practices and rules related to:* *Irrigation/watering of seedlings and home garden vegetables*	

	Irrigation systems (can describe mechanisms for water collection) *Practicing rainfed cultivation* *Adaptation to heterogeneous availability and quality of water (e.g. use of drought tolerant crops in some parts of the landscape, vegetative cover)*	
Reduction and minimization of water use	*If the following topics do not come up in the discussion on their own, inquire whether they have current practices and rules related to:* *Practices for water reuse and recycling*	

For questions 3.8-3.10 document the answer in the notes.

(3.8) How is the availability of water today? Is the water availability adequate to meet local needs?

(3.9) Have there been any changes in water availability (e.g. drying of water sources)? How has water supply changed in relation to water demand? What are the reasons for the changes? How is the community adapting?

(3.10) What, if any, are water quality issues your community is aware of? If so, how long has it been an issue? What do you think the causes of these are?

4. Energy (1 hour)

The following questions will explore the energy sources and demands for important livelihood activities in the community and how energy demands and availability is changing over time.

For questions 4.1-4.4 discuss and document the answers in the notes.

(4.1) Which activities or structures in the community are the most demanding of fuel or electricity?

(4.2) Which activities or structures (schools, churches, market spaces, processing facilities, etc) in the community require the most human energy (number of people, time or difficulty of work)?

(4.3) Which are the most important energy sources for the community? What is the reason for their importance (e.g. used for many diverse uses, essential for income generation, essential for subsistence food production, most people using them)?

(4.4) How much time in a day do people spend collecting fire wood or other fuel sources? Who in the community is responsible for this task?

Prepare a blank paper for questions 4.5-4.8 with the headings in the table below. Considering the activities listed one by one discuss and document in the table:

(4.5) What different tools are used for [*activity*] and the associated energy sources? e.g. wood, wood residues, crop residues, manure, domestic waste, charcoal, oil, diesel, wax, gas, human, animal, water/hydro, wind, sunlight, electricity from solar panel, electric grid, other

(4.6) Are any practices or tools used in the community to conserve and reduce the amount of fuel, electricity or human labour needed for [*activity*]?

(4.7) How have the tools/technologies, energy sources, and energy conservation practices used by the community for [*activity*] changed over time?

(4.8) What are the effects of changes in practice for [*activity*]?

Activity	Current tools, energy sources, and practices to optimize energy use	Traditional technologies tools, energy sources, and practices to optimize energy use
Cultivation (soil preparation, seeding, weeding, watering, harvesting)	*e.g. Tractor (diesel), shovel (human), modern and traditional hoe (human)*	*e.g. Plough (animal or human), traditional hoe (human)*
Herding and maintaining livestock		
Hunting	*e.g. Ski-doo (gasoline)*	*e.g. dog sled*
Fishing	*e.g. Motor powered boat (diesel)*	*e.g. traditional boat*
Wild edible collection (plants, mushrooms, honey, etc)	e.g. special tool for reaching fruits	
Processing food products (milling, drying, etc.)	*e.g. rice mill for milling rice (human),*	*e.g. grinding stone (human)*
Cooking	*e.g. improved wood stove (wood), solar oven (solar)*	
Transportation of people and products	*e.g. SUV (gasoline)*	*e.g. donkey cart (animal)*
Heating		
Lighting	e.g. solar panel (solar)	
Powering electronic devices		*e.g. not available before 2000*
Other important energy demanding activity		

For questions 4.9-4.14 discuss and document the answer in the notes.

(4.9) Is the supply of fuel and electricity adequate for the needs of the community and the local food system? How does the current fuel and electrical supply match demand?

(4.10) Has demand for fuel and electrical energy changed over time? What are the reasons for the changes?

(4.11) Has the use of fuel and electricity sourced from outside the local landscape changed over time? What has driven the change in fuel and electricity supply and what has been the result?

(4.12) Is the availability or accessibility of some energy sources changing (e.g. specific species)? Why? How is the community adapting?
(4.13) Is the supply of human labour adequate to the needs of the community and the local food system? How is current labour supply match demand?

(4.14) Has demand for human labour changed over time for livelihood activities? Has the level of drudgery changed over time? What are the reasons for the changes?

5. Waste (30 minutes)

The following questions will explore local practices for waste management and recycling and how the production and management of waste are changing over time.

For questions 5.1-5.3 discuss and document the answers in the notes.

(5.1) What type of waste products are created by households and the community?

(5.2) What are the biggest sources of waste in the community?

(5.3) Are there specific areas where rubbish and sewage are deposited in the community landscape or on household land?

Prepare a blank paper for questions 5.4-5.5 with the headings in the table below. Considering the activities listed one by one discuss and document in the table:

(5.4) Can you describe your activities related to [*activity*] in the community and households?

(5.5) Are current practices different from traditional practices related to [*activity*]? What were traditional practices and what were the reasons for these practices?

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Disposal or use of kitchen scraps		
Disposal or use of crop residues		
Disposal or use of animal urine and manure		
Disposal or use of animal urine human urine and manure		
Disposal or use of other organic/biodegradable materials		
Disposal of other non-biodegradable materials		
Safe disposal of chemicals, toxins and pollutants		
Reuse and recycling of materials		
Reduction or minimization of waste creation		
Others		

For questions 5.6-5.7 discuss and document the answers in the notes.

(5.6) Are current strategies for waste disposal and recycling sufficient to ensure a clean environment and efficient use of resources?

(5.7) Has the amount have waste produced or the adequacy of waste management changed over time? How and why? How is the community adapting?

6. Pest and disease regulation (1 hour)

The following questions will explore pest and disease management strategies in the community and how they are changing over time.

For questions 6.1-6.3 discuss and document the answers in the notes.

(6.1) What are the major pests and disease that the community faces for production of their major livelihood resources *(consider weeds, insects, fungus, viral or bacterial disease, rodents, wildlife, etc.)*? What damage do they cause?

(6.2) Which crops and animals are most affected by pests and diseases?

(6.3) Do they know of the natural enemies for their major pests? Where do these natural enemies live?

Prepare a blank paper for questions 6.4-6.5 with the headings in the table below. Considering the activities listed one by one discuss and document in the table:

(6.4) What practices are used by the community for [*activity*]?

(6.5) Are current practices different from traditional practices related to [*activity*]? What were traditional practices and what were the reasons for these practices?

Activities	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Management of pests and diseases affecting livestock		
Management of pests and diseases affecting crops during production stages	*Examples such as:* *Use of natural pesticide or fungicide (specify type e.g. neem);* *Spreading ash on leaves* *Companion planting with pest deterring plants* *Intercropping and planting variety mixtures (specify crops and rationale)* *Crop rotation and fallowing (specify crop sequence and rationale)* *Maintaining and encouraging the presence of natural enemies of pests (specify how this is done)*	
Weed control		
Protection of products from storage pests	*Examples such as:* *Enclosing seeds in plastic containers*	*Examples such as:* *Traditional granaries* *Traditional treatments of seeds and food stored*

For questions 6.6-6.7 discuss and document the answers in the notes.

(6.6) How effective are pest and disease control strategies in the community?

(6.7) Have there been any changes the in pests and diseases affecting crops and animals? Have any new pests or diseases appeared? Have any disappeared? How is the community adapting?

7. Pollination (30 minutes)

The following questions will explore strategies for ensuring sufficient pollination in the community and how they are changing over time.

For question 7.1 discuss and document the answers in the notes.

(7.1) How are the plants they rely upon for livelihoods pollinated? Do certain insects, bats, birds, the wind, play a role, and\or people?

Prepare a blank paper for questions 7.2-7.3 with the headings in the table below.

(7.2) What practices are used by the community to ensure adequate pollination?

(7.3) Are current practices different from traditional practices related to ensure adequate pollination? What were traditional practices and what were the reasons for these practices?

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Ensuring pollination		

For questions 7.4-7.5 document the answers.

(7.4) Is pollination is sufficient for local needs? Are some crops or plants important to the food system inadequately pollinated?

(7.5) Is the availability of pollinators changing? How? Why? How is the community adapting?

8. Integrated production (1 hour)

Prepare a blank paper for questions 8.1-8.4 with the headings in the table below. Considering the activities listed one by one discuss and document in the table:

(8.1) Does the community follow specific crop rotations? In a single plot, are some crops planted one after the other in a defined series over the seasons or over several years? What are the crop sequences used, the time frames and rationale?

(8.2) Does the community follow practices of intercropping (planting several crop species together in one plot)? Which plants are intercropped and what is the reason for planting the crops together?

(8.3) Are there some specific crop-tree, tree-tree, animal-tree, or crop-animal-tree combinations used in the landscape? What is the reason for these practices?

(8.4) Are current practices for crop rotation, intercropping and agroforestry different from traditional practices? What were traditional practices and what were the reasons for these practices?

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Crop rotations and land fallowing (changes in the crops planted over time and space)	*Examples such as:* *Improved potato-minor tubers-fava-fallow 7 years –maintains soil fertility, crops later in cycle are more tolerant of marginal soils*	
Intercropping and mixed cropping (planting crops simultaneously in the same plot)	*Examples such as:* *Intercropping maize-bean-squash* *Mixed planting of several native potato varieties*	
Agroforestry (specific associations of trees, crops and/or animals)		

For questions 8.5-8.6 document the answers in the notes.

(8.5) What are the positive and negative connections between crops and livestock (including aquaculture)?

(8.6) What are the positive and negative connections between natural areas and the farm or community?

9. Resilience elements (30 minutes)

Throughout this series of focus groups, we are making an assessment of elements in the systems that contribute to its resilience, or the capacity to deal with change and continue to develop; withstanding shocks and disturbances and using such events to catalyse renewal and innovation.

We would like to take a minute to reflect on the discussion today and discuss one indicator of resilience in the production system. For this indicator, we would like you to reflect and provide a score for the community on a scale of 1 to 5 and indicate the trend for the indicator. First everyone can score the indicator for themselves and then we can discuss and come to a consensus answer.

Start a blank piece of paper to document the results in a table with the headings: indicator, score, trend, and notes. Add the names of the indicators and consensus scores, trends and reasons as the discussion progresses. Allow time for an open conversation about the implications and reasoning behind the perceptions of the participants.

Landscape integration

(9.1) Are ecological interactions between different parts of the landscape (or seascape) considered while managing natural resources? (e.g. livestock, crops, forests, aquaculture, and different species thereof) *Discuss and decide on a consensus score: (5) Very high (Ecological interactions are considered while managing natural resources); (4) High; (3) Medium; (2) Low; (1) Very low (Ecological interactions are not considered while managing natural resources).*

(9.2) Is the community considering these interactions more, less or the same now as in the past? *Discuss and decide on a consensus score*

(9.3) What is the reason for the score and trend? *Document the reasons for the score and trend well in in the notes.*

Landscape/seascape diversity

(9.4) Is the landscape/seascape composed of diverse natural ecosystems (terrestrial and aquatic) and land uses?

Discuss and decide on a consensus score: (5) Very high (high preservation of local breeds and varieties); (4) High; (3) Medium; (2) Low; (1) Very low (There are very few or no local breeds and varieties).

(9.5) Is landscape/seascape diversity increasing, decreasing or remaining stable? *Discuss and decide on a consensus score.*

(9.6) Why has this score and trend been assigned? *Document the reasons for the score and trend well in in the notes.*

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Ask feedback

Round of thanks

Thematic Discussion 3. Exchange, trade, and marketing

Objective

This discussion will explore the market linkages of the community and its level of input of energy, seed, food, and information from areas outside the community landscape and how this has been changing over time.

Participants

group n.1	Men	10-15 men of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)
group n.2	Women	10-15 women of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)

Outline of the session

1. Income (30 minutes)

2. Agri-food product marketing (1 hour)

3. Market sourcing (1 hour)

4. Barter and exchange (1 hour)

5. Change Timeline (1.5 hours)

6. Resilience elements (30 minutes)

Total estimated time: 5-6 hours

Materials

Coloured markers and large sheets of paper

Start with an icebreaker and documentation of the group participants. Communicate the expected programme and timing of breaks during the day.

1. Income (30 minutes)

Prepare a blank paper for question 1.1 with the heading "Professions in the community" and free list. For gender specific groups all questions can focus specifically on the gender of the group.

(1.1) What are the different professions of people in your community? (teacher, shaman, labourer, artists, street food venders, blacksmiths, potters, etc.).

Prepare a blank paper for question 1.2 with the headings in the table below. Rank on a scale of 1-5 considering with higher numbers indicating sources that have a greater contribution to the incomes of more people in the community. For gender specific groups all questions can focus specifically on the gender of the group.

(1.2) How important are agrifood products, wild sourced products, on farm labour, and off farm activities for income in the community?

Income source	Rank (1-5)
Agrifood products	
Wild sourced products	
On farm labour	

Off farm activities	

Prepare a blank paper for question 1.3 with the heading "Main uses of cash income" and free list. For gender specific groups all questions can focus specifically on the gender of the group.

(1.3) What are the main uses for cash income in the community? (e.g. food, transport, energy, technology, internet, savings, education for the children, investment in productive activities, etc.)

2. Agri-food Product marketing (1 hour)

Prepare a blank paper for question 2.1 with the heading "Principle agri-food products" and free list. For gender specific groups all questions can focus specifically on the gender of the group.

(2.1) What agri-food products are sold by the community considering both local production and wild sourcing?

For crops and livestock, are improved or traditional varieties marketed (indicate the variety)?

Prepare a blank paper for question 2.2 with the heading "Processed products made for the market" and free list.

(2.2) Do community members process and package agri-food products specifically for the market? If yes, what products are produced and how are they processed?

Do community members sell products under any label/certification mechanism?

Prepare a blank paper for question 2.3 with the headings in the table below and document the discussion.

(2.3) Do local people work together to market local products?

Are collectives or groups engaged in marketing local crop and animal products?

What activities do they carry out (e.g. aggregation, storage, basic cleaning and grading, transformation and recipe preparations, packaging)?

What are the advantages and challenges of collective marketing efforts in the community?

Collectives/groups	Activities	Advantages

For questions 2.4 and 2.5 the facilitator will use as many large blank pieces of paper to draw the different value chains that exist in the food system making sure to indicate the scale (local, regional, or national) of the final consumer. If it would be clarifying, the facilitator may use different coloured markets to indicate key stakeholders in the value-chain. Please take a picture after the value chain drawings have been completed.

(2.4) Who are the main buyers of products from the community (i.e. to whom does the community sell the product directly)? Are there multiple buyers?

(2.5) Where and in what kind of markets do the products reach their final consumers?

Are they sold to local, regional, urban, or international consumers?

Some examples are detailed below:

Producer → Consumer (local)

Producer → Local Market Vendor → Consumer (local)

Producer → Collective → Processing and Packaging → Shops in the region → Consumer (regional)

Producer → Collective → Distributer → Supermarket → Consumer (national and international)

Producer Subsistence (home consumption)

Prepare a blank paper for question 2.6 with the heading "Challenges for marketing" and free list.

(2.6) Do community members have any issues in accessing the markets to sell their agricultural/food products?

Are community members able to access markets and buyers easily?

Are there adequate number of buyers for local products?

Do community members get a fair price?

What are the main challenges faced with marketing of local agri-food products?

3. Market sourcing (1 hour)

*Prepare a blank paper for question 3.1 with the heading "Foods sourced from the market" and free list***.**

(3.1) What foods are sourced from the market by the community?

Document 3.2 and 3.3 in chart below. To support the estimation, provide the participants 10 stones, and explain that they represent all the food that is consumed in one day or week. Ask them to divide the stones according to the three sources.

(3.2) What proportion of a local family's food is (estimate the % of food consumed over the year):

Produced by farming crops or animals?

Collected, hunted or fished from the wild?

Bought or bartered?

(3.3) How much money do you estimate that an average household typically spends on purchasing foods and drinks? What percent of their total income is spent on food and drinks?

Sourcing	Proportion of family's food over the year
Produced by farming crops or animals	
Collected, hunted or fished from the wild	
Bought, gifted or bartered	
Percent of income spent on food	

Record answers to 3.4 and 3.5 in the following chart. List markets in the following chart and indicate how far and how often they are open. To support the estimation, provide the participants 10 stones, and explain that they represent all the food that is purchased or bartered. Ask them to divide the stones according to the different markets and stores that they frequent.

(3.4) What markets do community members access to purchase food? How often are the markets open (e.g. every day, every week, etc.).

3.5 What is the importance of different markets and stores for local diets in terms of the amount of food sourced?

Market	Location	Importance

Freelist or discuss questions 3.6-3.10, results should be recorded primarily by the notetaker.

(3.6) How is the quality of the food products in the markets?

(3.7) Is healthy food available in the markets? Do some markets have healthier foods available?

What are healthy foods?

Are fresh fruits and vegetables available in markets? Do some markets have more fresh foods available?

(3.8) Is the food in the market affordable for everyone?

Are prices for basic food supplies accessible for all?

Do prices encourage people to buy healthy and fresh foods?

Are some foods unattainable to some households and why?

(3.9) Does the community have any issues in accessing food in the market?

Is supply sufficient in quantity, regularity, quality?

Are there some seasons where less diverse products are available?

Are markets easily accessible?

(3.10) Are there any foods or drinks you wish were available for purchase in your community but are not? Are they locally produced? Why do you aspire to eat or consume them?

Prepare a blank paper for question 3.11 with the heading "Non-foods products sourced from the market" and free list.

(3.11) Aside from food and beverages, what other products are sourced from the market by the community?

4. Barter and exchange (1 hour)

Prepare the chart shown below and record answers from questions 4.1-4.3.

(4.1) Does the community exchange goods or services with other communities or producer groups?

If so, what products are exchanged?

Are there standard ratios used in these exchanges? How often do these exchanges happen?

(4.2) Do community members exchange products with other members of the community? What products are typically exchanged?

Are there standard ratios used in these exchanges? How often do these exchanges happen?

(4.3) Are some food products commonly gifted in the community?

What products?

How often/when does this happen?

	Goods or services	Terms and frequency of exchange
4.1 Products exchanged with other communities or producer groups		
4.2 Products exchanged within the community		
4.3 Products gifted within the community		

5. Changes overtime (1.5 Hours)

Freelist or discuss questions 5.1-5.5, results should be recorded primarily by the notetaker.

(5.1) How have the major income sources for the community changed over time? When and why have changes occurred?

(5.2) Has the community need for income changed over time? When and why?

(5.3) Has the level and adequacy of income earned in the community changed over time? When and why?

(5.4) How has market sourcing of food and other products relevant to the local food system changed over time? What have been the effects of these changes for local environmental and human health?

(5.5) Have the relations for trade, exchange, and gifting food products within and between communities changed over time? How were these relations in the past? Why have they changed? What have been the consequences of the change?

6. Resilience elements (30 minutes)

Throughout this series of discussions, we are making an assessment of elements in the systems that contribute to its resilience, or the capacity to deal with change and continue to develop; withstanding shocks and disturbances and using such events to catalyse renewal and innovation.

We would like to take a minute to reflect on the discussion today and discuss two indicators of resilience related to the community connectivity. For each, we would like you to reflect and provide a score for the community on a scale of 1 to 5 and indicate the trend for the indicator. First everyone can score the indicator for themselves and then we can discuss and come to a consensus answer.

Start a blank piece of paper to document the results in a table with the headings: indicator, score, trend, and notes. Add the names of the indicators and consensus scores, trends and reasons as the discussion progresses. Allow time for an open conversation about the implications and reasoning behind the perceptions of the participants.

Appropriately connected

(6.1) Does the community collaborate with multiple suppliers, outlets, and fellow farmers to access the foods, products and services that they require? *Discuss and decide on a consensus score: (5) Very high (The community collaborates with multiple suppliers, outlets and fellow farmers to access the foods, products and services they require); (4) High; (3) Medium; (2) Low; (1) Very low (The community has few sources for the foods, products and services they require and have issues with irregular supply)*

(6.2) Is the level of connection and collaboration increasing, decreasing or remaining stable?

(6.3) Why this score and trend assigned?

Reasonably profitable

(6.4) Do people in the community earn a liveable wage from food-production activities (including workers and landowners) without relying on subsidies? *Discuss and decide on a consensus score: (5) Very high (food producers earn a liveable wage and food production does not rely on subsidies) (5); (4) High; (3) Medium; (2) Low; (1) Very low (food producers do not earn a liveable wage and food production relies on subsidies)*

(6.5) Is the level of profitability of the local food system increasing, decreasing or remaining stable?

(6.6) Why this score and trend assigned?

Indiginous peoples marketing approaches (1.5 hour)

TO ADD – sharing options for marketing resulting from literature review in output 2: Section under development.

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Ask feedback

Round of thanks

Thematic Discussion 4: Seasons, climate shocks and change

Objective

This discussion will explore the seasonality of the community and experience of climate shocks and observations of change.

Participants

group n.1	Men	10-15 men of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)
group n.2	Women	10-15 women of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)

Outline of the session

1. Annual calendar (1 hour)

1. Seasonality of diets and food transformation (1 hour)

2. Climate shocks and changes (1 hour)

3. Climate regulation (1 hour)

4. Crop and animal adaptation (30 minutes)

5. Seed security (30 minutes)

6. Food security coping strategies (40 hour)

7. Resilience elements and conclusion (20 minutes)

Total estimated time: 6 hours

Start with an icebreaker and documentation of the group participants. Communicate the expected programme and timing of breaks during the day

1. Annual calendar (1 hour)

Prepare the chart shown below and record answers from questions 1.1-1.5. For gender specific groups, focus especially on elaborating the activities for the gender of the group.

(1.1) What are the months in the local calendar?

(1.2) What are the climate seasons experienced over the year?

(1.3) What are the major activities carried out by local men and women in the food system over the year, especially related to securing food and livelihoods (e.g. farming and collection of foods from the wild, food processing, etc.)?

Do women and men have different responsibilities and activities over the year?

(1.4) What are the signs that the community has traditionally looked for to guide their food system activities?

e.g. What signs guide when to start or finish the activities listed in the calendar? Over the year, are certain signals sought to decide when to plant, when to change the fields of their animals, when to hunt, when to fish, etc.?

What are the signals community members look for to know how the weather will be in the short term, or over the season?

(1.5) Has the community noticed changes in the seasonal calendar? Are there changes in the seasons and natural signals used by the community to guide their livelihood activities?

How long ago did they notice the changes?

What actions are being taken to adapt?

Months (adjust to local calendar)	Season	Activities in the food and livelihood system (mark as men or women if gender-specific)	Signals	Changes	Adaptation
January					
February					
March					
April					
May					
June					
July					
August					
September					
October					
November					
December					

2. Seasonality of diets, food storage and transformation (1 hour)

Freelist or discuss questions 2.1-2.6, results should be recorded primarily by the notetaker.

(2.1) Do diets change much over the year? How do they vary? Are some species or foods eaten more or less at some times of year?

(2.2) Does the amount of food sourced from the landscape and the market change over the year?

Are wild foods more prominent in diets at certain times of year? Which ones, when and why?

Are foods produced on the farm more important in diets at certain times of year? Which ones, when and why?

Are foods obtained from the market more prominent in diets at certain times of year? Which ones, when and why?

(2.3) Are there times of year when it is more challenging to ensure there is enough food for people to not feel hungry? What is the reason?

(2.4) Are there times of year when it is harder to provide preferred foods?

(2.5) Are some foods stored by households to enable their consumption over a longer period? Which foods are stored?

What practices and techniques are used for storage?

Do community members process/transform some products for preservation (e.g. dried, salted, pickled) to enable storage over the year?

How long can the foods be stored?

(2.6) Were foods transformed or processed more or differently in the past for storage?

How has the transformation of products changed over time?

What is the reason for the changes in practice?

3. Climate shocks and changes (1 hour)

Prepare the chart shown below and record answers from questions 3.1-3.3. For gender specific groups, focus especially on elaborating the activities for the gender of the group.

(3.1) In what years has the community experienced major climate shocks (e.g. drought, flood, major storm, pest)?

(3.2) What was the effect of these shocks?

(3.3) How did the community recover? What did the community learn/ did they change its practices as a result?

Climate event or shock	Effects	Recovery	Lessons and adaptation

Freelist or discuss questions 3.4-3.6, results should be recorded primarily by the notetaker.

(3.4) Do extreme climate events happen more, less or just as often as the past?

(3.5) Have other changes or trends been observed in the weather and environment?

(3.6) When did these changes start?

4. Climate regulation (1 hour)

Freelist or discuss questions 4.1-4.5, results should be recorded primarily by the notetaker.

(4.1) Are there areas in the landscape that are more vulnerable to flooding, landslides, drought, frost/hail, or other climate hazards? Why are these areas more affected by these risks? *Ask participants to describe relevant areas*

(4.2) Are there areas in the landscape that are more resistant to flooding, landslides, drought, frost/hail, or other climate hazards? Why are they more resistant? *Ask participants to describe relevant areas*

(4.3) Does the community apply any strategies for managing the landscape to mitigate and regulate climate risks?

(4.4) Did they apply any strategies for managing the landscape to mitigate and regulate climate risks in the past?

What are traditional practices for climate regulation?

Do they still apply these practices?

(4.5) Are strategies for climate regulation applied in the community adequate for regulating the climate risks that are faced?

5. Crop and animal adaption (1 hour)

Freelist or discuss questions 5.1-5.7, results should be recorded primarily by the notetaker.

(5.1) Are some climate stresses especially damaging to local food production? *Freelist or discuss*

(5.2) Are some food plant or animals (species or specific varieties or breeds) particularly vulnerable to climate hazards? Which ones? *Freelist or discuss*

(5.3) Are some food plant or animals (species or specific varieties or breeds) particularly tolerant to the climate hazards experienced by the community? Which ones? *Freelist or discuss*

(5.4) How are stress tolerant crops and animals integrated into the landscape, farms and fields? *Freelist or discuss*

Are they able to support harvest security in times of climate stress?

(5.5) Has there been a change in the use or role of stress tolerant crops over time? *Freelist or discuss*

(5.6) Are there local practices followed for ensuring crop and animal adaptation (e.g. quality and resistance)? *Freelist or discuss*

Do community members try new varieties and breeds? What practices are followed to access new seeds?

Do community members follow any practices for seed or breed selection or breeding? What practices are followed?

Do community members follow any practices for crop or animal selection or breeding? What practices are followed?

Are some people in the community have a special role or relevance for seed and breed selection?

(5.7) Have practices for ensuring crop and animal adaptation changed over time? *Freelist or discuss*

What were traditional practices?

6. Seed security (30 minutes)

Prepare the chart shown below and record answers for question 6.1.

(6.1) Has the community ever experienced seed loss due to extreme climate events? When and for which crops? How did they recover?

Crop or Seed	Event that caused loss	Recovery

Prepare the chart shown below and record answers for question 6.2.

(6.2) What are the seed sources accessed by the community?

Are seeds regularly shared within the community? For which crops?

Are seeds regularly shared with other communities? For which crops? From which other communities?

Are some varieties accessed from the market, government, NGOS, or research institutes? For which crops? From which source?

Are some crops primarily sourced from farm-saved seed? Which ones?

Seeds shared in community	Seeds shared with other communities	Seeds accessed from market, government, NGO, etc.	Seeds sourced from farm-saved seed	Other sources

Prepare the chart shown below and record answers for questions 6.3-6.4 .

(6.3) What are the breed sources accessed by the community? Are some breeds accessed from the market, government, NGOS, etc.?

Are some breeds primarily sourced from local farms? Which ones?

(6.4) Are current practices for seed sourcing and breeding animals different from traditional practices? What were the traditional practices for obtaining seeds?

When did they change their seed sourcing practices? What is the result of the change?

Breeds shared in community	Breeds shared with other communities	Breed accessed from market, government, NGO, etc.	Other breed sources

7. Food security coping strategies (1 hour)

In communities around the world, food insecurity takes many forms and different levels of severity. Food insecurity has been described as:

Worrying that you would not have enough food to eat

Not having access to healthy and nutritious food

Eating only a few kinds of foods

Skipping meals

Eating less than you thought you should

Not having enough food in the household

Feeling hungry but not eating

Going a whole day without eating food

For questions 7.1-7.4 prepare the chart shown below and record answers.

(7.1) Do you think that any of these conditions were experienced in your community over the year? Are there any other coping strategies that are adopted by people in the community in times of need over the year (e.g. begging, migrating, and eating the seeds reserves)?

(7.2) Are some conditions more pronounced at certain times of year?

(7.3) Which experiences do you think are experienced by more and less people in the community?

(7.4) Are these issues of food insecurity linked to specific events or climate hazards?

Coping Strategies	When and/or why?	Times of year	Experienced by many or few people	Linked to specific events?

Freelist or discuss questions 7.5-7.7, results should be recorded primarily by the notetaker.

(7.5) What are local strategies followed to overcome periods of food insecurity?

Do some local plants or animals play a role?

(7.6) Where do people find support during periods of food insecurity?

Do people help one another in times of need?

Are there local organizations or the government that can turned to for support?

(7.7) Are current food security coping strategies different from traditional practices?

How was it in in the past? Is it changing now? Why?

8. Resilience elements and conclusion (30 minutes)

Throughout this series of discussions, we are making an assessment of elements in the systems that contribute to its resilience, or the capacity to deal with change and continue to develop; withstanding shocks and disturbances and using such events to catalyse renewal and innovation.

We would like to take a minute to reflect on the discussion today and discuss two indicators of resilience related to the community connectivity. For each, we would like you to reflect and provide a score for the community on a scale of 1 to 5 and indicate the trend for the indicator. First everyone can score the indicator for themselves and then we can discuss and come to a consensus answer.

Start a blank piece of paper to document the results in a table with the headings: indicator, score, trend, and notes. Add the names of the indicators and consensus scores, trends and reasons as the discussion progresses. Allow time for an open conversation about the implications and reasoning behind the perceptions of the participants.

Recovery and regeneration

(8.1) Does the local food system have the ability to recover and regenerate after extreme environmental shocks? *Discuss and decide on a consensus score: (5) Very high (Very high ability to recover and regenerate); (4) High; (3) Medium; (2) Low; (1) Very low (Very low ability to recover and regenerate)*

(8.2) Is the capacity of the increasing, decreasing or remaining stable?

(8.3) Why score or trend assigned?

Innovation in agriculture and conservation practices

(8.4) Does the community develop, improve and adopt new agricultural, fisheries, forestry, and conservation practices and/or revitalize traditional ones to adapt to changing conditions, including climate change*? Discuss and decide on a consensus score: (5) Very high (The community is receptive to change and adjusts its practices); (4) High; (3) Medium; (2) Low; (1) Very low (The community is not receptive to change and makes few innovations)*

(8.5) Is ecosystem protection increasing, decreasing or remaining stable?

(8.6) Why score or trend assigned?

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Ask feedback

Round of thanks

Thematic Discussion 5: food system institutions AND Governance

Objective

This discussion will explore the governance of natural resources and their sustainability. Participants in the different groups will be asked to assess some aspects of the governance.

Participants

group n.1	Men	10-15 men of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)
group n.2	Women	10-15 women of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)

Outline of the session

1. Natural resource governance (2 hours)

2. Rights and access to natural resources (1.5 hour)

3. Food system institutions (1.5 hour)

4. Social Services and health (30 minutes)

5. Community Cohesion and Strength (30 minutes)

Total estimated time: 6 hours

Start with an icebreaker and documentation of the group participants. Communicate the expected programme and timing of breaks during the day.

1. Natural resource governance (2 hours)

For question 1.1-1.2 prepare the chart shown below and record answers.

(1.1) Are there local traditional institutions that govern the use of natural resources? If yes, how do they work? What rules do they enforce?

(1.2) Have new institutions been created more recently to govern the use of natural resources? If yes, how do they work? What rules do they enforce?

Institution	When and who initiated?	Activities, processes and Rules	Who participates and level of participation?

Start a blank piece of paper to document the results in a table with the headings: indicator, score, trend, and notes. Add the names of the indicators and consensus scores, trends and reasons as the discussion progresses. Allow time for an open conversation about the implications and reasoning behind the perceptions of the participants.

<u>Community-based landscape/seascape governance</u>

(1.3) Is there a multi-stakeholder platform or institution able to effectively plan and manage natural resources in the landscape? *Discuss and decide on a consensus score: (5) Very high (Landscape/seascape platform or institution is capable of transparent, participatory, and effective decision making); (4) High; (3) Medium; (2) Low; (1) Very low (There is no multi-stakeholder landscape platform or institution).*

(1.4) Is community-based landscape governance increasing, decreasing or remaining stable? *Discuss and decide on a consensus score*

(1.5) Why score and trend? *Document the reasons for the score and trend well in in the notes.*

<u>Cooperation across the landscape/seascape</u>

(1.6) Is there connection, coordination and cooperation within and between communities for the management of natural resources? *Discuss and decide on a consensus score: (5) Very high (There is a very high level of cooperation and coordination in natural resource management across communities); (4) High; (3) Medium; (2) Low; (1) Very low (There is little or no cooperation and coordination in natural resource management between communities).*

(1.7) Is cooperation between communities for natural resource management increasing, decreasing or remaining stable? *Discuss and decide on a consensus score*

(1.8) Why score and trend? *Document the reasons for the score and trend well in in the notes*

<u>Ecosystem protection</u>

(1.9) Are there areas in the landscape or seascape where ecosystems are protected under formal or informal forms of protection? *Discuss and decide on a consensus score: (5) Very high (Key resources are under some form of protection); (4) High; (3) Medium; (2) Low; (1) Very low (There are no areas under protection).*

(1.10) Is ecosystem protection increasing, decreasing or remaining stable? *Discuss and decide on a consensus score*

(1.11) Why score or trend assigned? *Document the reasons for the score and trend well in in the notes*

<u>Sustainable management of common resources</u>

(1.12) Are common resources managed sustainably (in a way that will enable their persistence into the future)? *Discuss and decide on a consensus score: (5) Very high (Common resources are sustainably managed); (4) High; (3) Medium; (2) Low; (1) Very low (Common resources are overexploited or depleted).*

(1.13) Is sustainable management of common resources increasing or decreasing? *Discuss and decide on a consensus score*

(1.14) Why score and trend assigned? *Document the reasons for the score and trend well in in the notes*

2. Rights and access to natural resources (1.5 hour)

Prepare a blank paper for questions 2.1 with the heading “land ownership” and free list. For gender specific groups all questions can focus specifically on the gender of the group.

(2.1) Are there areas in the landscape that are privately owned, communally owned, government owned? Are there any areas where ownership is disputed?

Prepare a blank paper for questions 2.2 with the heading "transfer of land" and free list. For gender specific groups all questions can focus specifically on the gender of the group.

(2.2) How is land handed down generation to generation?

Prepare a blank paper for questions 2.3 with the heading "land owners outside of the community" and free list.

(2.3) Is land being sold, rented, or used by actors outside the community? *Freelist*

Rights in relation to land/water and other natural resource management

(2.4) Does the community have customary and /or formally recognized rights over land, (seasonal) pastures, water and natural resources? *Discuss and decide on a consensus score: (5) Very high (Rights are fully recognized and not disputed); (4) High; (3) Medium; (2) Low; (1) Very low ((Rights are not recognized and heavily disputed).*

(2.5) Are the community rights over land/water and other natural resources increasing, decreasing or remaining stable? *Discuss and decide on a consensus score*

(2.6) Why score and trend? *Document the reasons for the score and trend well in in the notes*

Socio-ecological mobility

(2.7) Are households and communities able to move around between different production activities and locations as necessary? (E.g. pastoralists shifting grazing areas) *Discuss and decide on a consensus score: (5) Very high (There are sufficient opportunities for mobility); (4) High; (3) Medium; (2) Low; (1) Very low (There are no opportunities).*

(2.8) Is socio-ecological mobility increasing or decreasing? *Discuss and decide on a consensus score*

(2.9) Why score and trend assigned? *Document the reasons for the score and trend well in in the notes*

Equitable resource access

(2.10) Is access to opportunities and resources fair and equitable for all community members, including women at household, community and landscape level? *Discuss and decide on a consensus score: (5) Very high (Access to resources and opportunities is fair and equitable at all levels); (4) High; (3) Medium; (2) Low; (1) Very low (Access to resources and opportunities is not fair and equitable).*

(2.11) Is the equitability of resource access increasing, decreasing, or remaining stable? *Discuss and decide on a consensus score*

(2.12) Why score and trend? *Document the reasons for the score and trend well in in the notes*

3. Food system institutions (1.5 hour)

For question 3.1-3.5 prepare the chart shown below and record answers.

(3.1) Are there local institutions, groups or initiatives that promote greater access for the community to locally-produced foods (e.g. farmer market or community garden)? If yes, how do they work? What are their activities?

(3.2) Are there local institutions, groups or initiatives that promote the cultivation and consumption of traditional foods? If yes, how do they work? What are their activities?

(3.3) Are there local institutions, groups or initiatives that support local people with information, guidance, and expertise on food production (e.g. cropping and livestock raising practices, veterinary services)? If yes, how do they work? What are their activities?

(3.4) Has the community initiated any institutions related to the food system?

(3.5) How strong is participation in local food system institutions?

Institution	When and who initiated?	Activities, processes and Rules	Who participates and level of participation?

For question 3.6 prepare the chart shown below and record answers.

(3.6) Is there sufficient access to information in the community regarding food production, marketing, nutrition, climate change, and other topics relevant to the food system?

Topics important to the food system	Sufficient access to information	Why or why-not
Food production		
Marketing		
Nutrition		
Climate change		
Other topics relevant to the food system		

4. Social services and health (30 minutes)

Prepare a blank paper for questions 4.1-4.2 and free list. For gender specific groups all questions can focus specifically on the gender of the group.

(4.1) Is local food integrated with social services such as caring for the elderly, schools and shops?

(4.2) How are the needs for people with disabilities, physical health or mental health issues addressed?

Start a blank piece of paper to document the results in a table with the headings: indicator, score, trend, and notes. Add the names of the indicators and consensus scores, trends and reasons as the discussion progresses. Allow time for an open conversation about the implications and reasoning behind the perceptions of the participants.

<u>Socio-economic infrastructure</u>

(4.3) Is the socio-economic infrastructure adequate for the needs of the community (e.g. health and education buildings and services)? *(5) Very high (The health situation and the environmental conditions are good); (4) High; (3) Medium; (2) Low; (1) Very low (The health and the environmental conditions are very bad)*

(4.4) Is the adequacy of socio-economic infrastructure increasing, decreasing, or remaining stable?

(4.5) Why has this score and trend been assigned?
Human health and environmental conditions

(4.6) What is the general health situation of local people also considering the prevailing environmental conditions? *(5) Very high (The health situation and the environmental conditions are good); (4) High; (3) Medium; (2) Low; (1) Very low (The health and the environmental conditions are very bad)*

(4.7) Are human health and environmental conditions increasing, decreasing, or remaining stable?

(4.8) Why has this score and trend been assigned?

5. Community cohesion and strengths (30 minutes)

Prepare the chart below for questions 5.1-5.3 and free list. For gender specific groups all questions can focus specifically on the gender of the group.

(5.1) Do people in the community work and celebrate together?

(5.2) Are people generally willing to take action for the good of the community?

(5.3) What do you consider the greatest strengths in the community?

Work and celebrate together	Willing to take action	Greatest Strengths

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Ask feedback

Round of thanks

Thematic Discussion 6: diversIty in the diet and production system

Objective

The component on consumption aims to identify the species and food item composition in the diet and determine the contribution of agrobiodiversity towards community level dietary quality. It also aims to understand the food flows into the community, and the contribution of local agrobiodiversity to current diets

Participants

group n.1	Men	10-15 men of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)
group n.2	Women	10-15 women of mixed age (e.g. 3 aged 20-30; 3 aged 30-40; 3 aged 40-50, 3 aged 50-60, and 3 aged more than 60)

Outline of the session

1. Local perceptions of nutrition (45 minutes)
2. Local Food System Inventory (2 hours)
3. Diet Diversity (45 minutes)
4. Crop Varieties and Animal Breeds (1 hour)
5. Forage and feed diversity (30 minutes)
6. Non-food crops (30 minutes)
7. Resilience Elements (20 minutes)

Total estimated time: 6 hours

Start with an icebreaker and documentation of the group participants. Communicate the expected programme and timing of breaks during the day

1. Local perceptions of nutrition (45 minutes)

Freelist or discuss questions 1.1-1.6, results should be recorded primarily by the notetaker.

(1.1) Is there a local way of classifying different foods?

What are the foods that are grouped together by the traditional classification?

What are the characteristics of the different food groups?

(1.2) Are there local rules and practices followed to ensure proper nutrition?

Are there local rules and practices guiding how much to eat of different types of foods?

(1.3) Are current practices and rules guiding balanced diets and nutrition different from the past?

What are the traditional rules and practices for balanced diets and nutrition (e.g. traditional health foods, supplements, or ways of combining food)?

What are the reasons for any changes in practice?

(1.4) What does a person with good nutrition look like? What is their diet like? *Record all vignettes that are reported and record/draw on a flip chart. Once there are no more suggestions try and create one single vignette* *that captures the different elements that define good diet and nutrition. Re-read this to the group and ask for confirmation or any changes.*

(1.5) Have local diets in the community over the last year been adequate for nutritional needs? Why yes or no? *Reflect on the vignettes and compare if most people's diets within the community in the last 12 months have been adequate for their nutritional needs, that is, if most people fit the vignettes.*

(1.6) Are there any barriers to having a good diet?

2. Local food system inventory (2 hours)

A balanced diet composed of multiple food groups is a key element for nutrition and health. We would like to know more about the diversity of foods that are eaten in the community and where the foods are coming from to build an understanding of the local food system. We will go food group by food group, following the classification used by FAO.

Facilitator will draw the following chart on one or more large pieces of paper and completes questions 2.1-2.6. Refer to the lists of foods produced for each food group.

Create a freelist for questions 2.1-2.5 on one blank piece of paper with the title of each food group.

(2.1) Which [*Food group*] do you eat in your community that are produced in local farms and gardens?

(2.3) Which [*Food group*] do you eat in your community that are sourced from wild areas?

(2.4) Which [*Food group*] do you eat in your community are primarily sourced from the market?

(2.5) Which [*Food group*] do you eat in your community are obtained mainly from trading directly with other communities?

Repeat question 2.1-2.5 with each of the following food groups

Meat and flesh foods (*name the animal species providing products*)

Fish and seafoods (*name animal species providing products*)

Milk and milk products (*name animal species providing products*)

Starches

Pulses

Nuts and seeds

Fruits

Dark green leafy vegetables

Orange and red fleshed fruits and vegetables (Vitamin A rich)

Other vegetables

Insects

Sweets

Oils

Processed foods

(2.6) Are some foods not eaten by the community for cultural or religious reasons?

Types of foods	Produced locally	Wild sourced	Purchased in the market	Traded with other communities
Meat and flesh foods (name animal species providing products)				
Fish (name animal species providing products)				
Milk and milk products (name animal species providing products)				
Starches (cereals and tubers)				
Pulses				
Nuts and seeds				
Fruits				
Dark green leafy vegetables				
Orange and red fleshed fruits and vegetables (Vitamin A rich)				
Other vegetables				
Insects				
Sweets				
Oils				
Processed foods				
Foods not eaten by the community				

3. Diet diversity (45 minutes)

We would like to discuss how often you have consumed different food groups. We will go food group by food group.

Prepare the following chart on one or more large pieces of paper and completes questions 3.1-3.3. Refer to the lists of foods produced for each food group.

(3.1) Hold up your hand if you have eaten a food in each group in the last 24 hours.

(3.2) How frequently to people in the community usually consume these food groups?

(3.3) Are there times of year when the community eats these groups more or less often?

	Number of people who ate in last 24 hours	How frequently commonly consumed	Time of year eaten more, and reason	Time of year eaten less, and reason
Meat, fish and flesh foods (name the animal species providing products)				
Milk and milk products name animal species providing products)				
Starches				
Pulses				
Nuts and seeds				
Fruits				
Dark green leafy vegetables				
Orange and red fleshed fruits and vegetables (Vitamin A rich)				
Other vegetables				
Insects				
Sweets				
Oils				
Processed foods				

Freelist or discuss questions 3.4-3.6, results should be recorded primarily by the notetaker.

(3.4) Which groups have lowest consumption? Why are these foods consumed less than others?

(3.5) Would people be willing to eat them more often?

(3.6) Has there been a change in the consumption of these food groups over time? When and why?

4. Crop varieties and animal breeds (1 hour)

Review the results of the diet assessment for which foods are produced locally. Prepare the following table and document the participant's answers for questions 4.1-4.6.

(4.1) Are more than one variety or breed kept in the community for some crop and livestock species? Which ones? What are the varieties/breeds kept?

(4.2) Which varieties and breeds are local and which ones are introduced? From where and when were they introduced?

(4.3) Which varieties and breeds are grown by many people and which ones are grown more rarely?

(4.4) Which varieties and breeds are grown in large areas and which ones in small areas?

(4.5) Why are these different varieties and breeds maintained? What are the main features appreciated by the community?

(4.6) Are there any limitations or challenges with keeping the variety or breed?

Crop species	Variety name	Type and source (local, improved, hybrid, introduced)	Grown by many or few households	Large or small areas	Role in the system, why kept	Limitations or challenges
Maize	*White*					
	Yellow					
Beans	*Black*					
	Red					
	White					

5. Forage and feed diversity (30 minutes)

Prepare the table below and record the answers from questions 5.1-5.3.

(5.1) What are the sources of animal feed and forage used on farms in the community?

(5.2) Which of the animal feed and forage sources are cultivated, obtained from natural areas in the landscape, and sourced from the market/outside the community landscape?

(5.3) Which forage and feed sources are used in larger amounts or by more people? What is the reason?

Sources of Forage	Sourced from	How much is it used

6. Non-food crops (30 minutes)

Prepare the table below and record the answers from questions 6.1-6.3.

(6.1) Are there crops and livestock maintained in the farm that do not provide food or forage? What is their role (e.g. structural materials, containers, crafts, clothing, medicine, cosmetics, energy)?

(6.2) Are there plants or animals that are collected, hunted or fished in the landscape that do not provide food or forage? What is their role (e.g. structural materials, containers, crafts, clothing, medicine, cosmetics, energy)?

(6.3) Which of these non-food plants and animals are more commonly used in the community? Which are rarer?

Non-food crop, livestock, or wild resources	Use	Most used by the community

7. Resilience elements (20 minutes)

Throughout this series of discussions, we are making an assessment of elements in the systems that contribute to its resilience, or the capacity to deal with change and continue to develop; withstanding shocks and disturbances and using such events to catalyse renewal and innovation.

We would like to take a minute to reflect on the discussion today and discuss one indicator of resilience related to the community connectivity. We would like you to reflect and provide a score for the community on a scale of 1 to 5 and indicate the trend for the indicator. First everyone can score the indicator for themselves and then we can discuss and come to a consensus answer.

Start a blank piece of paper to document the results in a table with the headings: indicator, score, trend, and notes. Add the names of the indicators and consensus scores, trends and reasons as the discussion progresses. Allow time for an open conversation about the implications and reasoning behind the perceptions of the participants.

<u>Diversity of the local food system</u>

(7.1) Does the community consume a diversity of locally-sourced food? *Discuss and decide on a consensus score (5) Very high (Diversity of locally-sourced foods is very high and these foods are widely consumed); (4) High; (3) Medium; (2) Low; (1) Very low (There are very few or no locally-sourced foods)*

(7.2) Is the consumption of diverse local foods increasing, decreasing, or remaining stable?

(7.3) Why have this score and trend been assigned?

***

Ask feedback

Round of thanks

Thematic discussion 7: young peoples' knowledge and perceptions

Objective

The component on consumption aims to identify the species and food item composition in the diet and determine the contribution of agrobiodiversity towards community level dietary quality. It also aims to understand the food flows into the community, and the contribution of local agrobiodiversity to current diets

Participants

group n.1	Children	8-10 participants aged 7-12 mixed genders
group n.2	Youth	8-10 participants aged 13-15 mixed genders

Outline of the session

1. Meals and snacks (30 minutes)

2. Preferred and traditional foods (1 hour)

3. Production and wild sourcing of foods (1 hour)

4. Aspirations (15 minutes)

Total estimated time: 3 hours

Start with an icebreaker and documentation of the group participants. Ask the participants to present themselves (name, age) and to name their favourite fruit/ vegetable. Communicate the expected programme and timing of breaks during the day

1. Meals and snacks (30 minutes)

Prepare the table below and ask the children questions 1.1-1.5

(1.1) What meals do you eat in a day?

(1.2) Are any meals eaten outside the house?

(1.3) For meals outside the home (e.g. school meals): What is typically served?

(1.4) Do you eat any snacks? At what times of day?

(1.5) What snacks do you eat? Where do the snacks come from (e.g. home, school, collected along the road)?

Meals and snacks eaten in a day	Where are they eaten	What is eaten	What time

2. Preferred and traditional foods (1 hour)

Prepare the table below and ask the children questions 2.1-2.2 In the children's groups: give each child a paper and some coloured pens and encourage them to draw their favourite foods, allow 10 minutes and then share with the group what is their favourite food. Discuss to assess the level of knowledge the participants have on food production and preparation.

(2.1) What are your favourite foods? *Reassure them that there are no limitations on the type of food or meal type.*

(2.2) Where do these favourite foods come from? How are they prepared?

Favourite foods	Where are they from	Where are they prepared

Prepare the table below and ask the children questions 2.3-2.7. Discuss to assess the level of knowledge the participants have on food production and preparation.

(2.3) Are any of the groups' favourite foods a traditional food of the community? Which ones?

(2.4) Do you know of any other traditional foods?

(2.5) Does everybody know about this food?

(2.6) Do you like to eat it? Why or why not?

(2.7) Where do these traditional foods come from? How are they prepared?

Traditional foods	How many knew about the food	Preference (like, dislike, neutral)	Source and preparation

3. Production and wild sourcing of foods (1 hour)

Prepare the table below and ask the children questions 3.1-3.4.

(3.1) Do you participate in activities for collecting, hunting, trapping or fishing foods? What activities? Who do you do them with?

(3.2) Do you help with activities on the farm for cultivating plants? What do you help with? Who do you work with?

(3.3) Do you help with activities on the farm for maintaining animals? What do you help with? Who do you work with?

(3.4) Do you help with cooking and preparing foods? What do you help with? Who do you work with?

Activities	Who they do them with

Prepare the table below and ask the children questions 3.5-3.9.

(3.5) Do you collect, hunt, trap or fish any foods by yourself (e.g. for snacks)? Which ones? How did you learn about these foods?

(3.6) Have you cultivated any plants on your own for food? Which ones? Where? How did you learn about these foods?

(3.7) Do you keep any livestock (e.g. small animals) on your own for use as food? Which ones? Where? How did you learn about these foods?

(3.8) Do you share the foods you gather/hunt, cultivate or raise with other people? Who?

(3.9) Do you sell the foods you gather/hunt, cultivate or raise to other people? Who? Where? When?

Foods produced or wild sourced alone	How learned?	Who shared with (if anyone)	Sold? To whom and where?

4. Aspirations (15 minutes)

Freelist or discuss questions 4.1-4.3, results should be recorded primarily by the notetaker.

(4.1) Do you want to stay in the village?

Do you want to take over your family farm one day?

(4.2) What will your future lifestyle and production/sourcing be like?

Will you continue with your traditional food production and wild sourcing activities?

Would you take on new activities, jobs or professions?

(4.3) What would you like your diet to be like when you are an adult?

***

Ask feedback

Round of thanks

Closing meeting: food system sustainability and resilience

Objectives

The purpose of this meeting is to share all the results from the whole series of discussions for feedback and lesson sharing. Major lessons on diet quality, food security and resilience will be shared along with opportunities identified to improve these aspects. This meeting can be held along with a traditional food and seed fair to celebrate the conclusion of the project. The entire community is invited to participate.

Participants

Community leaders

Open invitation to all community members, ensuring gender and age representation

If manageable within timeline, representative/s of the research task force

Outline of the session

Opening and Introduction

Food system profile (inputs, outputs, market linkage)

Protection of rural livelihoods

Sustainable resource management

Resilience

Trends and future projections

Conclusions

To be developed based on actual results and with reference to the analysis guide that is under development.

Opening and Introduction

Summary of initiative and thematic discussions

Food system profile (inputs, outputs, market linkage)

Summarize the overview of the food system:

What are the outputs (foods, by-products, income)?

What are the inputs (energy, labour, seed, fertilizers, etc.)?

What and how much of energy, food, seed, and inputs are coming from outside the local landscape?

Protection of rural livelihoods

Does the food system provide a diverse diet? And sufficient food security? Did it in the past? What are some key insights for enhancing diet diversity/quality?

Does the food system provide adequate livelihoods/income? Are farms self-sufficient? Is there enough income? What is the level of labour required in the system compared to availability of labour?

Sustainable natural resource management

What are some key observations of efficient use of resources in the system and actions to conserve and protect natural resources? Are there good governance practices for natural resources?

Resilience

Present the results of the self-assessments of resilience indicators from thematic discussion 1-6. Which indicators are weak? Which indicators are strong? What are opportunities to strengthen weak indicators?

Trends and future projections

Summarize the trends observed throughout the discussions and the future projections for the food system made in TD1. Do they agree with the projections for the future? What do they see the role of their traditional knowledge systems in the future, especially in facing and adapting to climate change?

Conclusions

Final discussion and close of the initiative

***

Ask feedback

Round of thanks

Annex 1 –PARTNERS: LOCAL INDIGENOUS ORGANIZATIONS AND/OR RESEARCH INSTITUTIONS

The food systems and related communities for this initiative were selected based on the following criteria:

Communities who are still practicing distinctive and well preserved indigenous food systems.

Communities whose subsistence and livelihoods are still strongly linked to natural resources.

Communities where the task force members had already worked in the past and/or had data available.

Communities where the task force members had strong local partners.

Based on these criteria, it is envisaged that the work at the field level will be carried out by local partner organizations, in particular by a facilitator, a documenter and a translator (if needed). These individuals should be selected by the local partner (local indigenous organizations and/or research institutions) to undertake the work. The local partner is at the interface between the task force members of the initiative and the indigenous communities.

The local partners are ideally organizations with whom the task force members have already worked. These organisations have strong linkages with and access to the communities that will participate in the initiative. The local partners will implement the methodology in the spirit of Free, Prior and Informed Consent (FPIC).

Specific responsibilities of the local partners include:

Selection of the facilitators, documenters and translators for the thematic discussions, ensuring that appropriate facilitators lead the different discussions with the communities. For example, women facilitators should lead the discussions with the women groups.

Provision of the Terms of Reference of the selected facilitators, documenters and translators and any other local partners involved in the initiative. The TORs should be in line with the descriptions provided in Annex 1.

Coordination of the thematic discussions with different age and gender groups, while respecting the timeline. Thematic discussions of the different groups of participants can be carried out in parallel.

Report on the thematic discussions undertaken and share the template forms with the task force members soon after each thematic discussion.

Ensure that the thematic discussions are undertaken for each identified groups of participants (men and women of mixed age, and children/youth). These can also take place at the same time.

Take care of the logistics of the discussions, ensuring that they take place at appropriate time for the communities. In this context, the schedule of the discussions should be agreed upon by the community and communicated well in advance.

Ensure the provision of refreshments and other logistics.

Annex 2 –Data Collection Forms

Annex 2 is primarily intended for the notetaker to enhance their ability to assist the facilitator and to indicate where additional notes would enrich the data collection. Boxes marked in orange are for notetaker use only and specify where the notetaker should record additional information during focus groups discussions.

Preliminary key informant interview/s

The facilitator will prepare the following table to fill out with key informants during the preliminary key informant interviews. Please use the questions in the method guidebook to identify the answers to each question while also taking care to record additional or disputed information. The notetaker may use an identical form to record notes from the discussion.

1. Orientation to the community

1.1-1.7 The notetaker or facilitator will document key informant information

1.1 Name(s) of participating communities	
1.2 Population	
1.3 Ethnic Groups	
1.4-1.6 Languages	
1.7 Religion/ Religious practices	

2. Community structure and gender roles

2.1-2.7 The notetaker or facilitator will document key informant information

2.1 Community leaders	
2.2 Decision Making	

2.3 Community Organization	
2.4 Gender Roles	
2.5 Roles of Elders	
2.6 Roles of Children and Youth	
2.7 Relationships, Unions and Marriages	

3. Taboos and comfort in addressing sensitive topic

3.1-3.2 The notetaker or facilitator will document key informant information

3.1 Sensitive topics	
3.2 Sensitive topics regarding foods	

4. Community Territory

4.1-4.13 The notetaker or facilitator will document key informant information from participatory mapping

Land use	Where it is located	Changes (if yes when)	Reason

4.14-4.17 The notetaker or facilitator will document key informant information from participatory mapping

Questions	Notes
4.14 Land ownership	
4.15 Protected areas	
4.16 Fences and Boundaries	
4.17 Sacred Areas	

Thematic Discussion 1: Traditions and trends in the local food system

1. Community timeline

1.1-1.8 Document the events, changes, and trends from the timeline and additional notes in the following table. After the timeline is completed take a picture.

Event, change or trend	Year (time period)	Reasons and notes

2. Sufficiency

2.1. Document the results and additional notes in the following table. After the chart is completed take a picture.

Element	Change compared to past (more, less, same)	When change occurred and reasons
Amount of food eaten/sufficiency of food supply		
Nutrition and health of local people		
Amount of food sourced from the wild (collected, hunted or fished)		
Amount of food produced by the community (farming, livestock raising etc.)		

Adequacy or quality of forage		
Self-sufficiency of the community		

3. Food Traditions

3.1-3.3 Document the results of the discussion on traditional foods in the following table. Take a picture of the free list

3.1 Free list of traditional foods. Take a picture of the completed list	
3.2 Balance of traditional and non-traditional foods (%)	
3.3 Document the answer: How much do people consume traditional foods and drinks? Would they like to eat more of them?	

3.3-3.6 Document the results of the discussion on traditional crops, animals and forage sources in the following table. Take a picture of the free list.

3.4 Free list of traditional crop/varieties, animal/breeds and forage sources. Take a picture of the completed list	
3.5 Balance of traditional and introduced crops, breeds and forage sources (%)	
3.6 Document the answers: Would community members like to use more of their traditional crops/varieties, livestock/breeds, and forage sources?	

4. Maintenance and transmission of traditional knowledge

4.1-4.4 Document the answers that arise in the discussion of each question

4.1 Do community members want to maintain their traditions related to their local food system (production, collecting, sale and consumption of foods) into the future?	
4.2 Culture and Traditions being lost	
4.3 How traditional knowledge is maintained	
4.4 Changes in the transmission of traditional knowledge	

5. Future projections

5.1-5.5 Document the answers that arise in the discussion of each question

5.1 Future landscape predictions	
5.2 Future of Production, collection, hunting and fishing or foods	
5.3 Future of Production, collection, hunting and fishing or foods	

5.4-5.5 Document the answers that arise in the discussion of each question

5.4 Future of Diets	
5.5 Consequences of dietary changes	

6. Resilience elements

6.1-6.3 Document the answers that arise in the discussion of each question

Indicator	Score (1-5)	Trend (increasing, decreasing or stable)	Reasons	Observation on consensus process
6.1 Maintenance of local breeds and varieties				
5.2 Transmission of traditional knowledge				
6.3 Documentation of traditional knowledge				

Thematic Discussion 2: Sustainable natural resource use

1. Wild resources

1.1.-1.3 The facilitator will prepare the following table to fill out with participants during this section of the focus group. Document the answers in the following table. Take a picture of the papers once they are completed.

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Hunting and trapping animals		
Fishing		
Harvesting of wild plants or non-timber tree products (for food, medicine, fodder, etc.)		
Cutting of trees and collection of timber		
Grazing animals in natural areas		

1.4-1.5 Document the results of the discussions in the following table.

1.4 Availability of wild plants and animals	
1.5 Domestication of wild plants or animals	

2. Soil

2.1-2.3 Document the results of the discussions in the following table.

2.1 Soil characterization of landscape	
2.2 Signs of good soil for cultivation	
2.3 Soil heterogeneity in the landscape	

2.4-2.7 The facilitator will prepare the following table to fill out with participants during this section of the focus group. Document the answers in the following table. Take a picture of the papers once they are completed.

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Maintaining and enhancing soil fertility		
Erosion control		
Adapting to soil heterogeneity in the landscape		

2.8-2.9 Document the results of the discussions in the following table.

2.8 Sufficiency of soil quality	
2.9 Changes in soil quality	

3. Water

3.1-3.4 Document the results of the discussions in the following table.

3.1 Biggest water demands in the community	

3.2 Roles and responsibilities for water collection time and labor	
3.3 Heterogeneity of water supply in the landscape	

3.4-3.7 The facilitator will prepare the following table to fill out with participants during this section of the focus group. Document the answers in the following table. Take a picture of the papers once they are completed.

Activity	Current sources, practices and rules, reasons, and when adopted	Traditional sources, practices and rules, reasons, and when adopted
Ensuring adequate quantity and quality of drinking water		
Ensuring adequate quantity and quality of water for household use (cooking, hygiene, etc.)		
Ensuring adequate quantity and quality of animal drinking sources		
Ensuring adequate quantity and quality of water for cultivation and irrigation.		
Reduction and minimization of water use		

3.9-3.11 Document the results of the discussions in the following table.

3.9 Sufficiency of water supply	
3.10 Changes in water availability	

3.11 Water quality issues	

4. Energy

4.1-4.4 Document the results of the discussions in the following table.

4.1 Fuel and electricity energy demands	
4.2 Human energy demands	
4.3 Most important energy sources	
4.4 Roles and responsibilities in fuel collection	

4.5-4.8 The facilitator will prepare the following table to fill out with participants during this section of the focus group. Document the answers in the following table. Take a picture of the papers once they are completed.

Activity	Current tools, energy sources, and practices to optimize energy use	Traditional technologies tools, energy sources, and practices to optimize energy use
Cultivation (soil preparation, seeding, weeding, watering, harvesting)		
Herding and maintaining livestock		
Hunting		
Fishing		

Wild edible collection (plants, mushrooms, honey, etc.)		
Processing food products (milling, drying, etc.)		
Cooking		
Transportation of people and products		
Heating		
Lighting		
Powering electronic devices		
Other important energy demanding activity		

4.9-4.14 Document the results of the discussions in the following table.

4.9 Sufficiency of energy supply	
4.10 Change in energy demand for fuel and electricity	

4.11 Use of fuel and electricity from outside the landscape	
4.12 Changes in availability of energy sources	
4.13 Sufficiency in human labor	
4.14 Change in demand for human labor and drudgery	

5. Waste

5.1-5.3 Document the results of the discussions in the following table.

5.1 Waste products	
5.2 Biggest waste sources	
5.3 Areas where waste deposited	

5.4-5.5 The facilitator will prepare the following table to fill out with participants during this section of the focus group. Document the answers in the following table. Take a picture of the papers once they are completed.

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Disposal or use of kitchen scraps		
Disposal or use of crop residues		

Disposal or use of animal urine and manure		
Disposal or use of animal urine human urine and manure		
Disposal or use of other organic/biodegradable materials		
Disposal of other non-biodegradable materials		
Safe disposal of chemicals, toxins and pollutants		
Reuse and recycling of materials		
Reduction or minimization of waste creation		

5.6-5.7 Document the results of the discussions in the following table.

5.6 Sufficiency of waste management	
5.7 Changes in waste production and adaptation	

6. Pest and disease regulation

6.1-6.3 Document the results of the discussions in the following table.

6.1 Major pests and diseases affecting production	

6.2 Most susceptible corps and animals	
6.3 Natural enemies	

6.4-6.5 The facilitator will prepare the following table to fill out with participants during this section of the focus group. Document the answers in the following table. Take a picture of the papers once they are completed.

Activities	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Management of pests and diseases affecting livestock		
Management of pests and diseases affecting crops during production stages		
Weed control		
Protection of products from storage pests		

6.6-6.7 Document the results of the discussions in the following table.

6.6 Sufficiency of pest and disease management	
6.7 Changes in pests and disease and adaptation	

7. Pollination

7.1 Document the results of the discussions in the following table.

7.1 Pollinators	

7,2-7.3 The facilitator will prepare the following table to fill out with participants during this section of the focus group. Document the answers in the following table. Take a picture of the papers once they are completed.

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Ensuring pollination		

7.4-7.5. Document the results of the discussions in the following table.

7.4 Sufficiency of pollination	
7.5 Changes in pollination and adaptation	

8. Integrated Production

8.1-8.4 The facilitator will prepare the following table to fill out with participants during this section of the focus group. Document the answers in the following table. Take a picture of the papers once they are completed.

Activity	Current practices and rules, reasons, and when adopted	Traditional practices and rules, reasons, and when adopted
Crop rotations and land fallowing (changes in the crops planted over time and space)		
Intercropping and mixed cropping (planting crops simultaneously in the same plot)		
Agroforestry (specific associations of trees, crops and/or animals)		

9. Resilience elements

Indicator	Score (1-5)	Trend (increasing, decreasing or stable)	Reasons	Observation on consensus process

9.1 Landscape/seascape diversity				
9.2 Landscape integration				

Thematic Discussion 3. Exchange, trade, and marketing

1. Income

1.1 The facilitator will make a free-list on a blank piece of paper. Document the result in this form. Take a picture of the completed list.

Professions in the community

1.2 Document the result of the ranking in this form.

Income source	Rank (1-5)
Agrifood products	
Wild sourced products	
On farm labour	
Off farm activities	

1.3 The facilitator will make a freelist on a blank piece of paper. Document the result in this form. Take a picture of the completed list.

Main uses of cash income

2. Agri-food Product marketing

2.1-2.2 Document the results of the freelisting in the following tables.

2.1 Principle agrifood products sold by the community	
2.2 Processed products produced for the market	

2.3 Do local people work together for marketing local products?

Collectives/groups	Activities	Advantages

2.4-2.5 Value chain results

2.4 Buyers	2.5 Markets and final consumers
Value chain maps:	

2.6 Challenges for accessing the market

Challenges for marketing

3. Market sourcing

3.1- Document the foods free-listed

Foods Sourced from the market

3.2-3.3 Document the proportion estimated for family food sources and estimated percent of income spent on food

Sourcing	Proportion of family's food over the year
3.2 Proportion of family food produced by farming crops or animals	

3.2 Collected, hunted or fished from the wild	
3.2 Bought, gifted or bartered	
3.3 Percent of income spent on food	

3.4-3.5 Document the different markets visited, the importance to local diets and positive and negative aspects linked to those markets during the discussion

Markets	Location	Importance for providing most food

3.6-3.10 Document the results of the discussion

3.6 Quality of food in the markets	
3.7 Availability of healthy foods in the markets	
3.8 Affordability of foods in the market	

3.9 Issues in accessing the market	
3.10 Products not available that they wish were	

3.11- Document the non-food products sourced from the market free-listed

Non-food products sourced from the market

4. Barter and exchange

4.1-4.3 Document the products traded, bartered and exchanged directly with other communities and within the community

	Goods or services	Terms and frequency of exchange
4.1 Products exchanged with other communities or producer groups		
4.2 Products exchanged within the community		
4.3 Products gifted within the community		

5. Timeline

5.1-5.5 Document the results of the timeline discussion

Changes in income	

Changes in adequacy of income	
Changes in market sourcing	
Changes in trading relations with other communities	

6. Resilience elements

6.1-6.2 Document the results of the resilience elements discussion

Indicator	Score	Trend	Reasons	Notes on Consensus Process
Appropriately connected				
Reasonably profitable				

Thematic Discussion 4: Seasons, climate shocks and change

1. Annual calendar

1.1-1.5 Document the results of the discussion in the chart below. For gender specific groups, focus especially on elaborating the activities for the gender of the group.

Months (adjust to local calendar)	Season	Activities in the food and livelihood system (mark as men or women if gender-specific)	Signals	Changes	Adaptation

2. Seasonality of diets, food storage and transformation

2.1-2.6 Record the notes from the discussion in the following chart.

2.1. How do diets change over the year	
2.2. How does sourcing from the landscape versus market change over seasons	
2.3 Seasonal food shortages	

2.4 Seasonal shortage in preferred foods	
2.5 Food storage and processing practices	
2.6 Changes over time in food processing and storage practices	

3. Climate shocks and changes

3.1-3.3 The facilitator will make a table as blow. Document the results of the discussion in the table

Climate event or shock	Effects	Recovery	Lessons and adaptation

3.4-3.6 Record the changes that are described

Changes and trends (Indicate when they started)

4. Climate regulation

4.1 Areas more vulnerable to climate hazards (describe areas and the hazards they are susceptible to)	
4.2 Areas more resistant to climate hazards (describe areas and the hazards they are susceptible to)	

4.3 Strategies for landscape management to mitigate climate risk	
4.4 Traditional practices for landscape managemnte to mitigate risk	
4.5 Sufficiency of strategies applied	

5. Crop and animal adaption

5.1 Stresses damaging to food production	
5.2 Food plant and animals vulnerable to climate hazards (indicate specific susceptibilities)	
5.3 Food plant and animals tolerant to climate hazards (indicate specific susceptibilities)	
5.4 Integration of stress tolerant crops and animals.	
5.5 Changes in use of stress tolerant crops	
5.6 Local practices followed for crop and animal adaptation	
5.7 Changes in practices for crop and animal adaptation	

6. Seed security

6.1 Document the events and how they recovered as below

Crop or Seed	Event that caused loss	Recovery

6.2 The facilitator will prepare a table similar to below. Document the results.

Seeds shared in community	Seeds shared with other communities	Seeds accessed from market, government, NGO, etc.	Seeds sourced from farm-saved seed	Other sources

6.3-6.4 The facilitator will prepare a table similar to below. Document the results.

Breeds shared in community	Breeds shared with other communities	Breed accessed from market, government, NGO, etc.	Other breed sources

7. Food security coping strategies

7.1-7.4 Either pose the questions detailed in the method guidebook to the group of participants or provide the list on a large sheet of paper for reference.

Coping Strategies	When and/or why?	Times of year	Experienced by many or few people	Linked to specific events?

7.5-7.7 Document the discussion for the following questions

7.5 Strategies followed to overcome periods of food insecurity	
7.6 Where do people find support in periods of food insecurity?	
7.7 Changes in food security coping strategies	

8. Resilience elements and conclusion

8.1-6.2 Document the results of the resilience elements discussion

Indicator	Score	Trend	Reasons	Notes on Consensus Process
Recovery and regeneration				
Innovation in agriculture and conservation practices				

Thematic Discussion 5: Food system institutions and Governance

1. Natural resource governance

1.1-1.2 The facilitator will prepare a table similar to below. Document the results.

Institution	When and who initiated?	Activities, processes and Rules	Who participates and level of participation?

1.3-1.14. The facilitator will make a table similar to below. Document the results

Indicator	Score (1-5)	Trend (increasing, decreasing or stable)	Reasons	Observation on consensus process
Community-based landscape/seascape governance				
Cooperation across the landscape/seascape				
Ecosystem protection				
Sustainable management of common resources				

2. Rights and access to natural resources

2.1-2.3 The facilitator will make a table similar to below. Document the results

2.1 Land ownership (private, communal, government)	
2.2 How land is handed down generation to generation	
2.3 Land transfer outside of community?	

2.4-2.12. The facilitator will make a table similar to below. Document the results

Indicator	Score (1-5)	Trend (increasing, decreasing or stable)	Reasons	Observation on consensus process
Rights in relation to land/water and other natural resource management				
Socio-ecological mobility				
Equitable resource access				

3. Food system institutions

3.1-3.5 The facilitator will make a table similar to below. Document the results

Institution	When and who initiated?	Activities, processes and Rules	Who participates and level of participation?

3.6. The facilitator will prepare a table similar to below. Document the results.

Topics important to the food system	Sufficient access to information	Why or why-not
Food production		
Marketing		
Nutrition		
Climate change		
Other topics relevant to the food system		

4. Social services and health

4.1-4.2 Document results of discussion

4.1 Integration of local food with social services	
4.2 How are needs for people with disabilities addressed	

4.3-4.8 The facilitator will prepare a table similar to below. Document the results.

Indicator	Score (1-5)	Trend (increasing, decreasing or stable)	Reasons	Observation on consensus process

Socio-economic infrastructure				
Human health and environmental conditions				

5. Community cohesion and strengths

5,1-5.3 The facilitator will prepare a table similar to below. Document the results.

Work and celebrate together	Willing to take action	Greatest Strengths

Thematic Discussion 6: Diveristy in the diet and production system

1. Local perceptions of nutrition

1.1-1.6 Document the points raised in the discussion

1.1 Local food classification	
1.2 Local rules and practices for nutrition	
1.3 Changes in diet practices	
1.4 Characterization of good nutrition	
1.5 Adequacy of diets for nutrition	
1.6 Barriers for good nutrition	

2. Local food system inventory

2.1-2.5 Document the foods eaten in the community and where they are sourced in the following table

Types of foods	Produced locally	Wild sourced	Purchased in the market	Traded with other communities
Meat and flesh foods (name animal species providing products)				
Fish (name animal species providing products)				
Milk and milk products (name animal species providing products)				
Starches (cereals and tubers)				
Pulses				
Nuts and seeds				

Fruits				
Dark green leafy vegetables				
Orange and red fleshed fruits and vegetables (Vitamin A rich)				
Other vegetables				
Insects				
Sweets				
Oils				
Processed foods				
Foods not eaten by the community				

3. Diet diversity

3.1-3.3 The facilitator will make a table similar to below. Document the results.

	Number of people who ate in last 24 hours	How frequently commonly consumed	Time of year eaten more, and reason	Time of year eaten less, and reason
Meat, fish and flesh foods				
Milk and milk products				
Starches				
Pulses				
Nuts and seeds				
Fruits				
Dark green leafy vegetables				
Orange and red fleshed fruits and vegetables (Vitamin A rich)				
Other vegetables				
Insects				
Sweets				

Oils				
Processed foods				

3.4-3.6 Document the points raised in the discussion

3.4 Food groups with lowest consumption and why	
3.5 Willingness to eat foods with less consumption	
3.6 Change in consumption of food groups over time	

4. Crop varieties and animal breeds

4.1-4.6 The facilitator will make a table similar to below. Document the results.

Crop species	Variety name	Type and source (local, improved, hybrid, introduced)	Grown by many or few households	Large or small areas	Role in the system, why kept	Limitations or challenges

5. Forage and feed diversity

5.1-5.3 The facilitator will make a table similar to below. Document the results.

Sources of Forage	Sourced from	How much is it used

6. Non-food crops

6.1-6.3 The facilitator will make a table similar to below. Document the results.

Non-food crop, livestock, or wild resources	Use	Most used by the community

7. Resilience elements

7.1-7.3 The facilitator will make a table similar to below. Document the results.

Indicator	Score	Trend	Reasons	Notes on consensus process
Diversity of the local food system				

Thematic discussion 7: Young peoples’ knowledge and perceptions

1. Meals and snacks

1.1-1.5 The facilitator will prepare a table as below. Document the results.

Meals and snacks eaten in a day	Where are they eaten	What is eaten	What time

2. Preferred and traditional foods

2.1-2.2 The facilitator will prepare a table as below. Document the results.

Favourite foods	Where are they from	Where are they prepared

2.3-2.7 The facilitator will prepare a table as below. Document the results.

Traditional foods	How many knew about the food	Preference (like, dislike, neutral)	Source and preparation

3. Production and wild sourcing of foods

3.1-3.4 The facilitator will prepare a table as below. Document the results.

Activities	Who they do them with

3.5-3.9 Foods produced and sourced by children on their own

Foods produced or wild sourced alone	How learned?	Who shared with (if anyone)	Sold? To whom and where?

4. Aspirations

4.1 Desires to stay in the village	
4.2 Aspirations for future professions and productive activities	
4.3 Aspirations for the diet	

Annex 3 – Optional exercises

Some optional exercises are in links with each section of the methodology are proposed below. They may be done in association with the main discussion but most would require additional time and attention to develop.

Traditional recipe and food preparations

In addition to discussion traditional food preparations in the focus groups (FG.3), the community may wish to prepare a book of traditional recipes and food preparations for sharing locally or more widely.

Community biodiversity register

A community biodiversity register is a participatory tool that allows the monitoring of local agrobiodiversity and its uses. The biodiversity register can come in many forms but the idea is to document an inventory of all the biodiversity relevant to the community, especially focused on species of importance for food, along with associated traditional knowledge. Some characteristics that can be documented for each species or variety:

Resource available and how it is recognized (species, variety or other biological resources)

How it is utilized

Status (abundant or rare)

Change of status over time

Why it is important to conserve it

Who holds the traditional knowledge associated with the resource and how this knowledge is transmitted

Who makes decision concerning the management of the resource

To what degree and in what way is the resource shared within and outside the community or beyond

Source:
https://www.bioversityinternational.org/fileadmin/user_upload/online_library/publications/pdfs/Community_biodiversity_management/2.4.community_biodiversity_registers_Nepal.pdf

Traditional knowledge register

Similar to the traditional recipe book and community biodiversity register, a register of traditional knowledge for the management of natural resources could be prepared documenting relevant stories, myths, songs, and local practices. This register could take many different forms and capture different types of knowledge of interest to the communities for their own record and use.

Seasonal food availability calendar

To encourage use of local foods for enhanced diet quality, a seasonal food availability calendar can be prepared in a participatory manner that documents all the food species that are available each month of the year in local fields, wild spaces, and markets. For each species, the months of availability and the level of availability (low, medium, high) can be identified and the species classified into key food groups in order to encourage consumption of a diversity foods year round.

Identification of underutilized species

Around the world, many locally-available species are not being used to their full potential to contribute to livelihoods and nutrition. Such underutilized species can be identified by evaluating local diets in comparison to the availability of species on the market and in the production system.

Source: https://www.cabdirect.org/cabdirect/abstract/20083159264

Community engagement: Food fair, seed fair, traditional food fair

Communities may decide to organize food fairs, seed fairs or traditional food fairs to share and exchange within the village and with neighbouring villages their traditional knowledge, recipes, seeds and crop species.