



Food and Agriculture  
Organization of the  
United Nations



INTERNATIONAL YEAR OF  
ARTISANAL FISHERIES  
AND AQUACULTURE  
2022



## Pacific food systems

The role of fish and other aquatic foods for  
nutrition and health



# Pacific food systems

## The role of fish and other aquatic foods for nutrition and health

### Authors

Lydia O'Meara<sup>1,2</sup>, Philippa Cohen<sup>1,4</sup>, Rosemary I'ilu Kafa<sup>3</sup>, Jillian Tutuo Wate<sup>1</sup>, Joelle Albert<sup>5</sup>, Jessica Bogard<sup>6</sup>, Gianna Bonis-Profumo<sup>1</sup>, Sarah Burkhart<sup>7</sup>, Aurélie Delisle<sup>2</sup>, Simon Diffey<sup>3</sup>, Taati Eria<sup>9</sup>, Anna Farmery<sup>8</sup>, Karen Fukofuka<sup>10</sup>, Sangeeta Mangubhai<sup>11</sup>, Marisa E.V. Mitchell<sup>4</sup>, Elesiva Na'ati<sup>12</sup>, Joseph Nyemah Nyemah<sup>3</sup>, Tim Pickering<sup>12</sup>, Sarah Sutcliffe<sup>7</sup>, Libby Swanepoel<sup>7</sup>, and Shakuntala Thilsted<sup>1</sup>, Fiasili Vaeau Lam<sup>3</sup>

### Affiliation

- <sup>1</sup> WorldFish
- <sup>2</sup> Natural Resources Institute, University of Greenwich
- <sup>3</sup> Food and Agriculture Organization of the United Nations
- <sup>4</sup> ARC Centre of Excellence for Coral Reef Studies, James Cook University
- <sup>5</sup> Island Elements
- <sup>6</sup> Agriculture and Food, Commonwealth Scientific and Industrial Research Organisation
- <sup>7</sup> Australian Centre for Pacific Islands Research, University of the Sunshine Coast
- <sup>8</sup> Australian National Centre for Ocean Resources & Security, University of Wollongong
- <sup>9</sup> Ministry of Fisheries and Marine Resources Development (Kiribati)
- <sup>10</sup> TongaHealth, Tonga
- <sup>11</sup> Wildlife Conservation Society, Fiji
- <sup>12</sup> Pacific Community (SPC) – Public Health Division, Fiji

## Required citation:

O'Meara, L., Cohen, P.J., I'lu Kafa, R., Wate, J.T., Albert, J., Bogard, J., Bonis-Profumo, G., Burkhart, S., Delisle, A., Diffey, S., Eria, T., Farmery, A., Fukofuka, K., Mangubhai, S., Mitchell, M.E.V., Na'ati, E., Nyemah, J.N., Pickering, T., Sutcliffe, S., Swanepoel, L., Thilsted, S.H. and Lam, F.V. 2023. *Pacific food systems – The role of fish and other aquatic foods for nutrition and health*. Apia. <https://doi.org/10.4060/cc5796en>

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations (FAO) concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The mention of specific companies or products of manufacturers, whether or not these have been patented, does not imply that these have been endorsed or recommended by FAO in preference to others of a similar nature that are not mentioned.

The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

© FAO, 2023



Some rights reserved. This work is made available under the Creative Commons Attribution-NonCommercial-ShareAlike 3.0 IGO licence (CC BY-NC-SA 3.0 IGO; <https://creativecommons.org/licenses/by-nc-sa/3.0/igo/legalcode>).

Under the terms of this licence, this work may be copied, redistributed and adapted for non-commercial purposes, provided that the work is appropriately cited. In any use of this work, there should be no suggestion that FAO endorses any specific organization, products or services. The use of the FAO logo is not permitted. If the work is adapted, then it must be licensed under the same or equivalent Creative Commons licence. If a translation of this work is created, it must include the following disclaimer along with the required citation: "This translation was not created by the Food and Agriculture Organization of the United Nations (FAO). FAO is not responsible for the content or accuracy of this translation. The original [Language] edition shall be the authoritative edition."

Disputes arising under the licence that cannot be settled amicably will be resolved by mediation and arbitration as described in Article 8 of the licence except as otherwise provided herein. The applicable mediation rules will be the mediation rules of the World Intellectual Property Organization <http://www.wipo.int/amc/en/mediation/rules> and any arbitration will be conducted in accordance with the Arbitration Rules of the United Nations Commission on International Trade Law (UNCITRAL).

Third-party materials. Users wishing to reuse material from this work that is attributed to a third party, such as tables, figures or images, are responsible for determining whether permission is needed for that reuse and for obtaining permission from the copyright holder. The risk of claims resulting from infringement of any third-party-owned component in the work rests solely with the user.

Sales, rights and licensing. FAO information products are available on the FAO website ([www.fao.org/publications](http://www.fao.org/publications)) and can be purchased through [publications-sales@fao.org](mailto:publications-sales@fao.org). Requests for commercial use should be submitted via: [www.fao.org/contact-us/licence-request](http://www.fao.org/contact-us/licence-request). Queries regarding rights and licensing should be submitted to: [copyright@fao.org](mailto:copyright@fao.org).

# Contents

---

Acknowledgements	iv
Executive summary	v
<b>Introduction</b>	<b>1</b>
<b>Recommendation 1: Safeguard fish and other aquatic foods for sustainable healthy diets</b>	<b>5</b>
<b>Recommendation 2: Invest in multisectoral collaboration for nutrition</b>	<b>7</b>
<b>Recommendation 3: Protect natural resource supplies of biodiverse fish and other aquatic foods for diverse diets</b>	<b>9</b>
<b>Recommendation 4: Raise awareness of the nutritional and health benefits of eating fish and other aquatic foods</b>	<b>11</b>
<b>Recommendation 5: Design nutrition-sensitive initiatives for women and also children during the first 1000 days of life</b>	<b>13</b>
<b>Recommendation 6: Develop and deliver food preservation techniques appropriate for fish and other aquatic foods to fill seasonal, economic and geographic shortfalls</b>	<b>15</b>
<b>Recommendation 7: Strengthen trade and supply chains toward nutrition outcomes</b>	<b>17</b>
Bibliography	19

# Acknowledgements

---

This publication was written by the following authors: Lydia O'Meara,<sup>1,2</sup> Jillian Tutuo Wate,<sup>1</sup> Rosemary I'ilu Kafa,<sup>3</sup> Fiasili Vaeau Lam, Philippa Cohen,<sup>1,4</sup> Joelle Albert,<sup>5</sup> Jessica Bogard,<sup>6</sup> Gianna Bonis-Profumo,<sup>1</sup> Sarah Burkhart,<sup>7</sup> Aurélie Delisle,<sup>2</sup> Simon Diffey,<sup>3</sup> Taati Eria,<sup>9</sup> Anna Farmery,<sup>8</sup> Karen Fukofuka,<sup>10</sup> Sangeeta Mangubhai,<sup>11</sup> Marisa E.V. Mitchell,<sup>4</sup> Elesiva Na'ati,<sup>12</sup> Joseph Nyemah Nyemah,<sup>3</sup> Tim Pickering,<sup>12</sup> Sarah Sutcliffe,<sup>7</sup> Libby Swanepoel<sup>7</sup> and Shakuntala Thilsted<sup>1</sup>.

This work was supported by a grant from the United Nations' Food and Agriculture Organization (FAO) (LOA/RAP/2020/47: Building capacity and awareness on fisheries and nutrition in the Pacific food system) as part of the Hand-in-Hand (HiH) Initiative under the FAO Programme Priority Area Better Nutrition. This work was undertaken as part of the [CGIAR Research Program on Fish Agri-Food Systems \(FISH\)](#) and the Resilient Aquatic Food Systems Initiative, led by [WorldFish](#). These programmes are supported by contributors to the [CGIAR Trust Fund](#). This work was made possible through the generous collaboration and expert input provided by: the University of Greenwich, James Cook University, Island Elements; Commonwealth Scientific and Industrial Research Organisation, University of the Sunshine Coast, University of Wollongong, Kiribati Ministry of Fisheries and Marine Resources Development, TongaHealth, Wildlife Conservation Society, and the Pacific Community (SPC).

<sup>1</sup> WorldFish.

<sup>2</sup> Natural Resources Institute, University of Greenwich.

<sup>3</sup> Food and Agriculture Organization of the United Nations.

<sup>4</sup> ARC Centre of Excellence for Coral Reef Studies, James Cook University.

<sup>5</sup> Island Elements.

<sup>6</sup> Agriculture and Food, Commonwealth Scientific and Industrial Research Organisation.

<sup>7</sup> Australian Centre for Pacific Islands Research, University of the Sunshine Coast.

<sup>8</sup> Australian National Centre for Ocean Resources & Security, University of Wollongong.

<sup>9</sup> Ministry of Fisheries and Marine Resources Development (Kiribati).

<sup>10</sup> TongaHealth, Tonga.

<sup>11</sup> Wildlife Conservation Society, Fiji.

<sup>12</sup> Pacific Community (SPC) – Public Health Division, Fiji.

# Executive summary

---

Fish and other aquatic species play key ecological roles in the Pacific's exceptionally biodiverse ocean. The cultures, livelihoods, food and incomes of Pacific Island nations are intertwined with ocean ecosystems. The majority of Pacific Islanders live close to the coast, where harvesting, exchanging and eating fish and other aquatic foods are a part of daily life. Access to healthy coasts and oceans is foundational to the human right to culturally appropriate foods. And so for Pacific Islanders, the production, distribution and consumption of fish and other aquatic foods are central to livelihoods, income generation, and cultural and social identity.

Rates of fish consumption amongst some Pacific Island nations and populations are among the highest in the world. Yet while such high consumption of fresh fish would suggest a healthy diet there are several trends that mean many people do not experience diverse diets and good nutrition. Fish consumption in the Pacific region differs across demographic groups and, overall, is on the decline. The Pacific is experiencing a decline in public health, in part, because of the transition away from local, and towards globalized food systems – which, in turn, is driven by an increasingly cash-based economy and easy access to cheap, highly processed, nutrient-poor, imported foods. Because of shifts in broader dietary patterns, Pacific Islanders are struggling with the triple burden of malnutrition: undernutrition, micronutrient deficiencies and overnutrition.

Fish and other aquatic foods provide a rich source of micronutrients, omega-3 fatty acids and lean protein. These nutritional qualities are a necessary complement to the carbohydrate-rich diets among Pacific Islanders. Evidence shows that when fish and other aquatic foods are eliminated from diets, people do not get enough of these nutrients to meet their nutritional requirements.

Realizing and maintaining the full nutritional and health benefits of fish and other aquatic foods is important for many Sustainable Development Goals (SDGs) of the Pacific Islands. To realize this potential, action is needed to ensure that a diverse range of fish and other aquatic foods remains or becomes increasingly accessible and affordable for all women, men, youths, children and infants. To address the Pacific's malnutrition epidemic, a suite of structural, institutional, societal and individual changes is needed to transform the Pacific food system toward better nutrition.

Although fisheries and coastal resource management are useful entry points to improve nutrition, it is necessary to complement these initiatives with a suite of intersectoral interventions that address all upstream determinants of malnutrition, such as access to healthcare and education. The diagnosis and recommendations provided in this report consider nutrition improvements that fisheries can realize, alongside the complementary intersectoral actions that are also needed to improve nutrition and health among Pacific Islanders.

This report is intended for actors, policymakers and funders concerned with improving food and nutrition security with fisheries as an entry point. It is equally valuable for food system, agricultural, health and nutrition actors who are seeking to protect and enhance the benefits that fish and other aquatic foods provide to a diversity of nutrition goals.

This report has been developed from an extensive review of published scientific articles and technical reports, as well as interviews and consultations with 17 experts. It also draws upon insights from the Pacific Food System regional dialogues, which were held in the lead-up to the United Nations Food Systems Summit 2021. Here, we have distilled seven priority recommendations to guide programming, policy and investment decisions in the Pacific Islands (Figure 1):

- 1. Safeguard fish and other aquatic foods for sustainable healthy diets:** Recognize fish and other aquatic species not only as a biodiversity asset and a critical economic commodity, but also as integral to Pacific Island food and nutrition security.
- 2. Invest in multisectoral collaborations for nutrition:** Integrate activities, policies and actions related to fish, other aquatic foods and fisheries within wider nutrition, health and food system initiatives. This can be supported by convening intersectoral working groups and dialogues that span all levels of society and different sectors, specifically water, agriculture, fisheries, forestry, health and trade.
- 3. Protect aquatic ecosystems to ensure a continuous supply of biodiverse fish and other aquatic foods for diets:** When resources are managed sustainably and remain accessible for human consumption, aquatic ecosystems and natural resources provide the foundation for a healthy and resilient food system for Pacific Island nations – now and into the future.
- 4. Raise awareness of the nutritional and health benefits of eating fish and other aquatic foods:** Employ both targeted and mainstreamed awareness raising, within education and health information provision, to improve knowledge on the nutritional qualities and health benefits of eating fish and other aquatic foods as part of an overall healthy diet.
- 5. Design nutrition-sensitive strategies that serve women and also children during the first 1000 days of life:** Although fish consumption is *on average* high in Pacific Island nations, many women, children, and people living further inland do not eat enough fish and are deficient in the nutrients that fish contain, such as omega-3 fatty acids, vitamin A, iron, zinc and calcium. Awareness, education and behavior change (e.g., purchasing, consumption, preparation) are needed to help ensure that all women and children are sufficiently well nourished and eating the portion sizes required to meet their nutrient needs.
- 6. Develop and deliver food preservation techniques appropriate for fish and other aquatic foods to fill seasonal, economic and geographic shortfalls:** Establish or improve preparation and preservation techniques and promote the development of new culturally and socially acceptable fish-based products. Together, these two measures will increase affordability, reduce loss and waste, improve product safety and lengthen shelf life, which can help extend supply chains to inland populations or fill seasonal shortfalls.
- 7. Strengthen trade and supply chains toward nutrition outcomes:** Evaluate the inward gains and outward losses of nutrients that result from importing and exporting fish, aquatic foods and other foods. This evaluation could inform shifts in the governance of fisheries and food trade toward supply chain configurations that retain foods with the rich nutrient profiles within the region, and toward people experiencing nutritional vulnerability that Pacific Islanders need. Governments continue to generate income from fisheries access agreements and fish exports, such as through export taxes or rent acquired from high-seas tuna license fees – there are substantial opportunities to establish and refine distributive mechanisms that better direct public funds toward upstream determinants of health that support nutrition outcomes.



**Figure 1.** Seven recommended actions to improve the contribution that fish and other aquatic foods make toward transforming Pacific food systems for greater nutritional outcomes.



Source: Adapted with permission from Farmery, A.K., Scott, J.M., Brewer, T.D., Eriksson, H., Steenbergen, D.J., Albert, J., Raubani, J., Tutuo, J., Sharp, M.K. and Andrew, N.L. 2020. Aquatic foods and nutrition in the Pacific. *Nutrients* 12:1–22. doi: 10.3390/nu12123705

# Introduction

---

## The foundations and transitions of nutrition in the Pacific

The cultures, livelihoods, food and income of the 22 small island states of the Pacific Islands are intertwined with the ocean (Hau'ofa, 2008). Pacific Island nations possess large ocean spaces, relative to their small land areas, and Pacific Islanders enjoy a diverse, culturally rich and unique ocean-based way of life. Fish consumption in some Pacific nations ranks among the highest in the world, though with significant variation between and within countries (FAO, 2014). The Pacific Ocean houses the highest levels of marine biodiversity in the world, and a subset of these species support small-scale coastal fisheries that supply local diets as well as large-scale fisheries that export migratory species into international markets (Bell *et al.*, 2009; Charlton *et al.*, 2016). The predominantly rural populations engage heavily in small-scale and subsistence agriculture systems (Gillett and Tauati, 2018). As such, the cultures and societies of the Pacific Islands celebrate a rich tradition of local food production, and both marketing and social food exchange are a foundation of the resilience of local food systems and the food and nutrition security of rural and urban populations (Bogard *et al.*, 2021; Ferguson *et al.*, 2022).

As a result of globalization and urbanization over the past 50 years, the Pacific Island region is experiencing a transition from a subsistence economy to a cash-based economy (Campbell, 2020). Traditional foods and practices, which have been embedded in cultural obligations of reciprocity and kinship over time, remain key elements of the contemporary food system and are critical to meeting subsistence needs (Andrew *et al.*, 2021). However, traditional diets, based on local, wild-caught fish, tree crops and root vegetables, are now competing with an increasing abundance of cheap, ultra-processed, imported foods (Plate 1) (Hughes and Lawrence, 2005; Sievert *et al.*, 2019). This nutrition transition, as defined by Popkin *et al.* (2020), has led the societies of Pacific Island nations to experience the triple burden of malnutrition:

- **Undernutrition** is when a person is unable to eat enough food necessary for energy, growth and health, which can lead to potentially irreversible conditions such as stunting.
- **Micronutrient deficiencies** occur when a person, despite getting enough energy from their diet, has insufficient levels of vitamins and minerals, which can lead to conditions like iron-deficiency anemia.
- **Overnutrition** is when excess or imbalanced dietary energy intake can lead to overweight, obesity and diet-related noncommunicable diseases such as Type II diabetes and cardiovascular disease (Global Nutrition Report, 2020).

In the Pacific Islands, these three forms of malnutrition often coexist within the same community, and sometimes even within the same household. It is not uncommon for a household to have a child with stunted growth, a woman with a mineral deficiency and a woman or man with a diet-related noncommunicable disease (Hughes and Marks, 2009; FAO, 2021).

High rates of malnutrition are a persistent public health concern in the region. For example, rates of anemia are high among Pacific Islander women, and high levels of stunting continue to occur in children in Papua New Guinea, the Marshall Islands, Solomon Islands and Vanuatu (Global Nutrition Report, 2020). Although national nutrition surveys in the Pacific Islands are scarce, emerging evidence indicates that dietary quality is low (Thow, 2016; Goris *et al.*, 2017; Farrell *et al.*, 2019; Horsey *et al.*, 2019; O'Meara *et al.*, 2019; Albert *et al.*, 2020; Farmery *et al.*, 2020) and that the diets of many Pacific Islanders could be deficient in iron, zinc, calcium and vitamin A (FAO, 2019 and, 2020a; Eme *et al.*, 2020; FAO and SBS, 2020; EPPSO *et al.*, 2021; FAO and SPC, 2021; KNSO *et al.*, 2021).



**Plate 1.** The nutrition transition in the Pacific Islands from a traditional diet based on local fish, roots and tubers, and vegetables (left) to a diet of highly processed, imported foods that are often high in energy and low in nutrients (right).

## Food system and environmental and demographic change

At the center of the nutrition challenge in the Pacific Islands is a “broken” global food system that perpetuates high rates of malnutrition and environmental degradation (Willett *et al.*, 2019). Despite contributing less than 3 percent of global greenhouse emissions (FAO *et al.*, 2009), the region is at the frontline of the impacts of climate change. Because of this, Pacific Island nations experience more intense, rapid or expansive soil salination, ocean warming, sea-level rise, acidification and extreme weather, including droughts and cyclones – all of which reduce food and nutrition security (Charlton *et al.*, 2016; WFP and SPC, 2018). Many Pacific Islanders rely on wild or cultivated foods for diet quality (Bogard *et al.*, 2021), and rural households that grow their own food have higher dietary diversity in some contexts (O’Meara *et al.*, 2019). Yet local supplies of fish and other aquatic foods, vegetables and fruits still cannot meet domestic demand. Demand in the region outpaces supply for several reasons: climate change impacts, prioritization of production for international markets, production challenges and population growth (Bell *et al.*, 2009; Charlton *et al.*, 2016; McIver *et al.*, 2016; Campbell, 2020). Over the past 50 years, although agricultural production in the region has increased, per capita production of fruit, vegetables and fish has declined (Andrew *et al.*, 2021). As a result, the Pacific Islands are becoming more reliant on imports, which tend to be highly processed foods that are high in energy and low in nutrients (Thow *et al.*, 2011; Santos *et al.*, 2019). The increase in consumption of these foods is directly associated with the region’s epidemic of diet-related noncommunicable diseases (DiBello *et al.*, 2009; Hughes and Marks, 2009; Snowdon and Thow, 2013).

## Pacific Islands

In this report, we consider the Pacific Island region to consist of the 22 island countries and territories served by the Pacific Community (SPC) (Figure 2, Box 1). Over 95 percent of Pacific Islanders live within 10 km of the coast, many within just a few kilometers, the exception being Papua New Guinea, where half of the population lives more than 5 km inland (Andrew *et al.*, 2019). In coastal communities, harvesting fish and other aquatic foods from nearshore environments is a common activity (Cisneros-Montemayor *et al.*, 2016). Coastal fisheries provide between 50 percent and 90 percent of animal-source protein for Pacific Islanders (Bell *et al.*, 2009) and contribute on average about 50 percent of cash flowing into all Pacific households, according to a study from 2015 (SPC, 2015). The consumption rates of fish and other aquatic foods in Pacific Island nations are among the highest worldwide – with rural coastal people consuming between

47 and 126 kg per person annually (FAO, 2014). This far exceeds the global average of 20 kg. However, with the introduction of imported foods, such as chicken and low-quality red meat, fish consumption is on the decline, especially among urban populations (Eme *et al.*, 2020; FAO and SBS, 2020; FAO and SPC, 2021).

**Figure 2.** Pacific Island Countries and Territories



Source: UN. 2022. Web-services. In: Geospatial, location data for a better world. Apia. Cited 15 December 2022. [www.un.org/geospatial/mapsgeo/webservices](http://www.un.org/geospatial/mapsgeo/webservices)

## Fish and other aquatic foods

Animal-source foods are a compact and efficient source of micronutrients and protein that is easier to absorb compared with plant-source foods (Murphy and Allen, 2003). They are also one of the only sources of dietary vitamin B12, highly bioavailable iron and preformed vitamin A (Murphy and Allen, 2003). Within this food group, fish and other aquatic foods are important because they provide high concentrations of omega-3 fatty acids, a diverse range of minerals and vitamins, and lean protein per energy unit (Hicks *et al.*, 2019; Byrd *et al.*, 2021). They are one of the few natural food sources rich in both omega-3 fatty acids and iodine. These two nutrients alone are essential for brain development, childhood survival, cardiovascular system health, healthy pregnancy and safe delivery, and a healthy nervous system and thyroid (Kawarazuka and Béné, 2011; Charlton *et al.*, 2016). Furthermore, when animal-source foods such as fish are eaten with vegetables, the protein and heme iron they contain enhance the absorption of zinc (Sandstrom *et al.* 1989) and nonheme iron (Michaelsen *et al.*, 2009; Consalez *et al.*, 2022) from the vegetables.

## Nutrition-sensitive fisheries and agriculture

To achieve the UN SDGs, the Food and Agricultural Organization of the United Nations (FAO) recommends that all strategies to develop or “transform” food systems need to adopt an approach that positively influences nutrition – often called a “nutrition-sensitive approach” (Table 3) (FAO, 2015a and, 2017). Ultimately, this recognizes that food systems need to provide sufficient nutritious food in a way that improves the health of humans while limiting damage to the environment. Compared with nutrition-specific approaches, nutrition-sensitive actions, policies and initiatives address the underlying determinants

of nutrition. These determinants include patterns and adequacy of agricultural, fisheries and forestry production, social safety nets, gender equality, women's empowerment, and education, as well as access to water, sanitation and hygiene, and healthcare (FAO, 2018).

To conform with a nutrition-sensitive approach, food system actions, policies and initiatives need to align with international guidelines for sustainable healthy diets (FAO and WHO, 2019) and culturally appropriate traditional food systems. They must also align with regional or national food-based dietary guidelines, which for the Pacific Islands region are the Pacific Guidelines for Healthy Living (SPC, 2018).

From the outset, nutrition-sensitive approaches should have clear, logical pathways for an action, policy or initiative to improve nutrition. From design and inception, these approaches must determine how, where and for whom change will be measured and the degree of change an intervention is seeking and is able to detect. Monitoring and evaluating such approaches require explicit nutrition indicators, for which guidance, definitions and methodologies are available. These include indicators such as dietary diversity scores, nutritional adequacy of diets, nutritional status of individuals, and anthropometric measurements that indicate status and changes in stunting, wasting, overweight and obesity (FAO, 2015b). Step-by-step examples of designing nutrition-sensitive approaches in the Pacific Islands context exist and can be used as a guide (Albert and Bogard, 2015).

## Scope, methods and audience

In the seven sections that follow, we outline opportunities for research, investment, initiatives and policy changes that fit the contexts of the Pacific Islands nations in terms of food system characteristics, fish and aquatic food systems, and nutritional challenges. These recommendations would increase nutrition sensitivity and leverage the opportunities that fish and other aquatic foods provide toward improved nutrition and health. We recognize that transforming food systems and making gains in nutrition and health require complementary policies, programming and activities that span all types of foods and food system components. Nonetheless, the diagnosis and recommendations outlined here consider fish and other aquatic foods as an entry point that should be accompanied by complementary cross-sectoral changes at local to international levels.

This report provides diagnoses and recommendations that, if addressed, can help achieve the ambitions laid out in the UN Decade of Action on Nutrition (2016–2025), the UN Food Systems Summit 2021, the UN Decade of Ocean Science for Sustainable Development (2021–2030) and the International Year of Artisanal Fisheries and Aquaculture (2022). It was developed based on a review of published scientific articles and technical reports. The review was complemented with semi-structured interviews and follow-up discussions with diverse fisheries, nutrition, development and health experts, who all hold expertise and substantial experience in the Pacific Island region. Discussions and outcomes of the Blue Pacific Food System dialogues, held in preparation for the 2021 UN Food Systems Summit, also contributed to the report.

The expert interviews and the structure of this report were framed using (i) FAO's "Nutrition-sensitive agriculture and food systems in practice" (2017), (ii) FAO and WHO's "Sustainable healthy diets – Guiding principles" (2019) and (iii) the SPC's "Pacific guidelines for healthy living (2018). This report contributes to FAO's Hand-in-Hand Initiative under its Programme Priority Area Better Nutrition. It is intended to complement (i) the dialogues from the Regional Blue Pacific Food Systems (ii) the SPC's "A New Song for Coastal Fisheries – Pathways to Change" (2015) and (iii) the UN Food Systems Summit 2021.

This report is intended for people, organizations and funders focusing on oceans and fisheries and concerned with improving food and nutrition security. It is equally valuable for food system, agricultural, health and nutrition actors, as well as policies and investments. It provides rationale and guidance on how to protect and enhance the benefits of fish and other aquatic foods for nutrition and health.

# Recommendation 1: Safeguard fish and other aquatic foods for sustainable healthy diets

## **Safeguard the natural aquatic resource base for domestic consumption to contribute to sustainable healthy diets for Pacific Islanders**

The Pacific Ocean is the foundation of identity, culture, food and wealth for people of Pacific Island nations (Figure 4) (Hau'ofa, 2008). It boasts one of the richest marine ecosystems on Earth, which provide the foundations for nature-based solutions to safeguard coastal communities from climate change (Brodie *et al.*, 2013). However, climate change and broken food systems that perpetuate high rates of environmental degradation (Farrell *et al.*, 2020) impair the goods and services the ocean provides to communities (Bell *et al.*, 2009; McIver *et al.*, 2016). And ocean warming and acidification threaten the integrity of coral reefs, where many biodiverse aquatic foods are found (Brodie *et al.*, 2013). Moreover, the climate-driven redistribution of tuna stocks away from the exclusive economic zones of Pacific Islands nations means that almost half of these countries will experience a drop in tuna-related revenue (FAO *et al.*, 2009; FAO and SPC, 2012).

Fish and other aquatic foods are unique in that they are both nutritious (Hicks *et al.*, 2019; Byrd *et al.*, 2021) and, if appropriately managed (FAO, 2015c), often more environmentally sustainable

than land-based animal-source foods because they have a lower carbon production footprint (Clark *et al.*, 2019; Hallström *et al.*, 2019). Because of the multiple benefits of fish consumption for both human and planetary health, international guidelines recommend eating fish and other aquatic foods as part of a sustainable healthy diet (Box 1) (HLPE, 2014; FAO and WHO, 2019; Willet *et al.*, 2019; Ahern *et al.*, 2021).

If national development focuses too heavily on the sale of fish for international export (Cohen *et al.*, 2019; Belton *et al.*, 2020; Bennett *et al.*, 2021), this can inadvertently threaten the right of local populations to culturally appropriate food (Béné *et al.*, 2010; HLPE, 2020). Sustainability encompasses more than just the carbon footprint of foods. It also means that food systems need to provide culturally appropriate foods in a manner that is economically and socially feasible for future generations (Downs *et al.*, 2020; HLPE, 2020).

Over the past 50 years, there has been a heavy focus on Pacific Island fisheries as a source of income. This has led to the highest value fish and other aquatic foods, especially tuna, being exported to international markets (Gillett and Tauati, 2018) or diverted toward the tourism



A woman holds cooked, locally caught reef fish, Santupaele village, Western Province, Solomon Islands.

sector, impairing local food and nutrition security (Bell *et al.*, 2013). As rural economies increasingly become monetized, proportionally more fish is sold out from urban areas and less is kept for home consumption (Gillett and Tauati, 2018). This means that local supply is often inconsistent, of variable quality and highly priced, especially in urban areas, in comparison with low-quality imported animal-source foods (Snowdon and Thow, 2013).

In the Vava'u Declaration (2007) and "A new song for coastal fisheries – Pathways to change" (2015), Pacific Island leaders committed to supporting the development of innovative approaches to address

declines in coastal fisheries resources and related ecosystems, especially in the face of population growth and increased demand (SPC, 2015). However, more work is needed to ensure that "fish as food" (Bennett *et al.*, 2021) is appropriately integrated into the wider food system development plans. This will ensure that all Pacific Island countries today and into the future can harness the nutritional benefits of both coastal and offshore tuna fisheries (Bell *et al.*, 2009). Given the importance of fisheries for sustaining livelihoods, this requires investments in incentives to diversify opportunities and livelihood streams to remove pressure on the coastal fisheries (SPC, 2015).

### Box 1. Low trophic level fish and other aquatic foods and women fishers

To mitigate the environmental impacts of food production, it is important for people to eat a variety of low trophic level aquatic foods, such as small-bodied fish species, shellfish (particularly filter-feeding bivalve mollusks) and aquatic plants (Ahern *et al.*, 2021). There is a wide variety of fish and other aquatic foods, such as seaweed, mussels, oysters and clams, that are often overlooked in terms of their nutrient potential for sustainable healthy diets. Seaweed is a term used to broadly describe marine algae. This includes the most consumed forms, red, brown and green algae, which are all commonly found growing in nearshore areas and contain high levels of iron, calcium, vitamin A and fiber (Butcher *et al.*, 2020). Bivalve mollusks, such as mussels, mangrove oysters and clams, are good sources of omega-3 fatty acids, zinc, iron and vitamin B12 (Farmery *et al.*, 2020). These low trophic level aquatic foods, which are often more accessible for marginalized populations, provide an affordable and sustainable option to fill nutrient gaps. On top of all this, increasing consumer demand could also provide opportunities for marginalized women fishers to generate income, as well as include their voices and priorities in resource management decisions.

**Innovation:** Current consumption rates of low trophic species such as small-bodied fish species, shellfish and aquatic plants could be increased in the Pacific Islands. To maximize the development and nutritional impact of these species, like seaweed, consumption rates need to increase and technical support is required to build capacity and enterprise within appropriate coastal communities, especially with women, to ensure sufficient supply (Swanepoel *et al.*, 2020).

Peer-to-peer training between Pacific Islander women across different countries could be an effective method for celebrating culturally local foods, sharing knowledge and building capacity within the region. For example, Kiribati has potential to increase seaweed farming capacity but does not have a history of eating large amounts of seaweed. A recent project helped facilitate peer-to-peer training by flying women seaweed farmers from Samoa to Kiribati to teach the basics of seaweed harvesting, processing and recipe preparation for consumption (Swanepoel *et al.*, 2020). The project was positively received by Kiribati women. One described how "**watching the Samoan women allowed me to learn, understand and remember the knowhow; they show me it is so easy**" (Swanepoel *et al.*, 2020). The training also allowed local women to learn about what edible seaweed exists in Kiribati and which could be developed and form part of the diet for their families.

Notes:

Ahern, M., Thilsted, S., Oenema, S. and Kühnhold, H. 2021. *The role of aquatic foods in sustainable healthy diets*. UN Nutrition Discussion Paper. Rome: UN.

Butcher, H., Burkhart, S., Paul, N., Titiij, U., Tamuera, K., Eria, T. and Swanepoel, L. 2020. Role of seaweed in diets of Samoa and Kiribati: Exploring key motivators for consumption. *Sustainability* 12. doi: 10.3390/SU12187356

Farmery, A.K., Scott, J.M., Brewer, T.D., Eriksson, H., Steenbergen, D.J., Albert, J., Raubani, J., Tutuo, J., Sharp, M.K. and Andrew, N.L. 2020. Aquatic foods and nutrition in the Pacific. *Nutrients* 12:1–22. doi: 10.3390/nu12123705

Swanepoel, L., Tioti, T., Eria, T., Tamuera, K., Titiij, U., Larson, S. and Paul, N. 2020. Supporting women's participation in developing a seaweed supply chain in Kiribati for health and nutrition. *Foods* 9. doi: 10.3390/foods9040382

## Recommendation 2: Invest in multisectoral collaboration for nutrition

### **Invest and engage in multisectoral and cross-scale collaboration for improved nutrition by integrating fisheries initiatives within the wider nutrition, health, education and food system policy, planning and developments.**

Improving nutrition requires investing in multiple sectors to meet the needs of all people, especially the most nutritionally vulnerable. However, policy actions on food, health, agriculture, fisheries and climate are typically managed in isolation – an organizational approach that is inherently unsuited to managing complex food systems (FAO, 2018). There is a strong need to build capacity and platforms for intersectoral dialogue, policy and action among different organizations and government departments in the Pacific Islands (Mahmudiono *et al.* 2019; Brugere *et al.*, 2021).

Although addressing cross-sectoral links between government departments is critical, it is equally important to improve dialogue and planning

across levels, particularly between governments, community groups (Andrew *et al.*, 2020; Datta, 2021; Eriksson *et al.*, 2021) and the private sector to provide a collaborative approach that is more likely to achieve longer-term sustainable results to improving food and nutrition security and public health. This is critical to ensure trade-offs are not made between sectors, or one food sector (e.g. agriculture) does not impact the other (e.g. fisheries). This also includes collaborating with marginalized groups to tap into traditional knowledge and strengths of local communities, while fostering ownership and grassroots innovative change. Global analysis has shown that aquatic food systems are more equitable when policies and mechanisms focus explicitly on transparency, accountability and equitable representation of communities, particularly those vulnerable to malnutrition and political and economic marginalization.



Processed food for sale at a local store in Gizo, Western Province, Solomon Islands.



Improved data can help Pacific countries harness the nutritional potential of local foods to address the triple burden of malnutrition (Box 2). Current data can also help different sectors identify entry points for interventions to achieve common goals. First, addressing these data gaps requires cross-sectoral and cross-level approaches. High quality data on locally produced foods and intrahousehold consumption patterns would ensure that Pacific Island nations are able to match locally available nutrient-dense foods

with public health concerns by refining dietary guidelines to improve public health – now and into the future. Data gaps to address include (i) the nutritional composition of locally grown foods, (ii) what foods are being consumed, when and by whom, (iii) the sources of those foods and the characteristics of the food environments that influence food choices, and (iv) food handling and preparation skills on how to retain nutrients (Farmery *et al.*, 2020; Bogard *et al.*, 2021).

## Box 2. Data gaps in fish and other aquatic foods

For policymakers to understand which local foods to promote in order to safeguard biodiversity and diet diversity, better data is needed (Santos *et al.*, 2019; Farmery *et al.*, 2020; Byrd *et al.*, 2021). Globally, over 3000 types of fish and other aquatic foods are eaten as food (Golden *et al.*, 2021b), and each species has a substantially different nutrient profile (Hicks *et al.*, 2019; Farmery *et al.*, 2020; Bernhardt and O'Connor, 2021). However, data on the nutrient composition of many inland and marine species is missing, with composition available for only 25 percent of aquatic species consumed worldwide (Byrd *et al.* 2021).

**Innovation:** The Pacific Nutrient Database (SPC *et al.*, 2020) is a new food composition table database to help link food consumption data with the nutrient composition of local foods eaten in the Pacific. Both the Pacific Nutrient Database and the Household Income and Expenditure Surveys provide important data for analyzing diets and the potential of local foods to fill nutrient gaps.

Regular national nutrition surveys for each Pacific Island nation are needed to better quantify which foods are consumed, as well as their quantities and seasonality. It is important that data is collected within households in order to analyze the nutritional needs of each member, especially nutritionally vulnerable groups such as women and young children (FAO, 2015b).

It is also important to collect data on the consumption of individual foods. For example, reporting aquatic food consumption at the broad category of “fish” makes it difficult to evaluate the nutritional contribution of different species (Farmery *et al.*, 2020). Currently, only Fiji conducts a regular national nutrition survey, so support and technical capacity may be required to do so in the other 21 Pacific Island countries. Such surveys can also contribute valuable information on the sources from which foods are acquired (Bogard *et al.*, 2021).

### Notes

**Bernhardt, J.R. and O'Connor, M.I.** 2021. Aquatic biodiversity enhances multiple nutritional benefits to humans. *Proceedings of the National Academy of Sciences of the United States of America* 118:1–11. doi: 10.1073/pnas.1917487118

**Bogard, J.R., Andrew, N.L., Farrell, P., Herrero, M., Sharp, M.K. and Tutuo, J.** 2021. A typology of food environments in the Pacific region and their relationship to diet quality in Solomon Islands. *Foods* 10(11):2592.

**Byrd, K.A., Thilsted, S.H. and Fiorella, K.J.** 2021. Fish nutrient composition: A review of global data from poorly assessed inland and marine species. *Public Health Nutrition* 24:476–86. doi: 10.1017/S1368980020003857

**[FAO] Food and Agriculture Organization.** 2015b. *Compendium of indicators for nutrition-sensitive agriculture*. Rome: FAO.

**Farmery, A.K., Scott, J.M., Brewer, T.D., Eriksson, H., Steenbergen, D.J., Albert, J., Raubani, J., Tutuo, J., Sharp, M.K. and Andrew, N.L.** 2020. Aquatic foods and nutrition in the Pacific. *Nutrients* 12:1–22. doi: 10.3390/nu12123705

**Hicks, C.C., Cohen, P.J., Graham, N.A.J., Nash, K.L., Allison, E.H., D’Lima, C., Mills, D.J., Roscher, M., Thilsted, S.H., Thorne-Lyman, A.L. and MacNeil, M.A.** 2019. Harnessing global fisheries to tackle micronutrient deficiencies. *Nature* 574:95–98. doi: 10.1038/s41586-019-1592-6

**Santos, J.A., McKenzie, B., Trieu, K., Farnbach, S., Johnson, C., Schultz, J., Thow, A.M., Snowden, W., Bell, C. and Webster, J.** 2019. Contribution of fat, sugar and salt to diets in the Pacific Islands: A systematic review. *Public Health and Nutrition* 22:1858–71. doi: 10.1017/S1368980018003609

**[SPC] Pacific Community.** 2021. *13th SPC Heads of Fisheries Meeting: Synthesis of COVID-19 impacts on fisheries and aquaculture in the Pacific Information Paper 5*. Noumea, New Caledonia: SPC.

## Recommendation 3: Protect natural resource supplies of biodiverse fish and other aquatic foods for diverse diets

**Natural resources, including biodiverse fish and other aquatic foods, provide the foundation for healthy and resilient food systems in the Pacific Islands, supporting diverse diets and resilient food supplies – now and into the future.**

For optimal health and well-being, it is important to eat a variety of different food groups every day, including foods that strengthen the body and provide energy and protection (SPC, 2018). Moreover, because each food provides a different range of nutrients, it is important to eat a variety within each food group for optimal nutrition (Frison *et al.*, 2011; Fanzo *et al.*, 2013; Bernhardt and O'Connor, 2021).

Biodiversity is associated with food and nutrition security and higher dietary diversity in both

low- and middle-income countries (Jones, 2017), including those in Asia and the Pacific (Alva *et al.*, 2016; O'Meara *et al.*, 2019). In Solomon Islands, for example, the cultivated food environment is the source of 73 percent of fruit and 63 percent of vegetables, while the wild food environment, including the ocean, provides 72 percent of seafood acquired nationally (Bogard *et al.*, 2021). Similarly, indigenous smallholder farming households in rural Fiji exhibited higher household dietary diversity if they had access to high farm diversity and wild food sources, including traditional fishing grounds (O'Meara *et al.*, 2019). Moreover, biodiversity of wild foods is critical for the resilience of local food systems so that they can better withstand shocks like COVID-19 and climate extremes (Troell *et al.*, 2014; Béné, 2020; Love *et al.*, 2021).



Salted and dried fish, the Kingdom of Tonga.

While fish and other aquatic foods belong to the animal-source food group, their nutrient profile is substantially different from terrestrial meat (Golden *et al.*, 2021b). Eating a diversity of fish and other aquatic food species can broaden the range of nutrients in the diet (Bernhardt and O'Connor, 2021). In the Pacific Islands, more than 300 species of finfish and a range of invertebrate species and plants are harvested for consumption by small-scale fishers (Andrew *et al.*, 2020). Pelagic small fish and bivalves, in particular, are high in iron, zinc, and vitamins B12 and A (Figure 3) (Farmery *et al.*, 2020). Moreover, because pelagic small fish are often eaten whole, with the bones, they are a rich source of calcium (Farmery *et al.* 2020). The foundation for maintaining supplies of diverse

aquatic foods for local consumption is to protect local access and use rights and to strengthen resource stewardship through co-management and community-based participatory ecosystem planning (Albert and Bogard 2015; Tilley *et al.*, 2019a; Andrew *et al.*, 2020). Attention needs to include women and youths in decision-making processes so that they do not inadvertently experience reduced access to resources (Lawless *et al.*, 2019; Mangubhai and Lawless, 2021). Because coastal fisheries resources face natural limits to productivity, employing fish aggregating devices (FADs) to disperse fishing pressure and shifting fishing to high turnover, highly nutritious coastal species can increase access to aquatic foods (Box 3) (Albert *et al.*, 2014; Tilley *et al.*, 2021).

### Box 3. Fish aggregating devices (FADs) and fisheries co-management

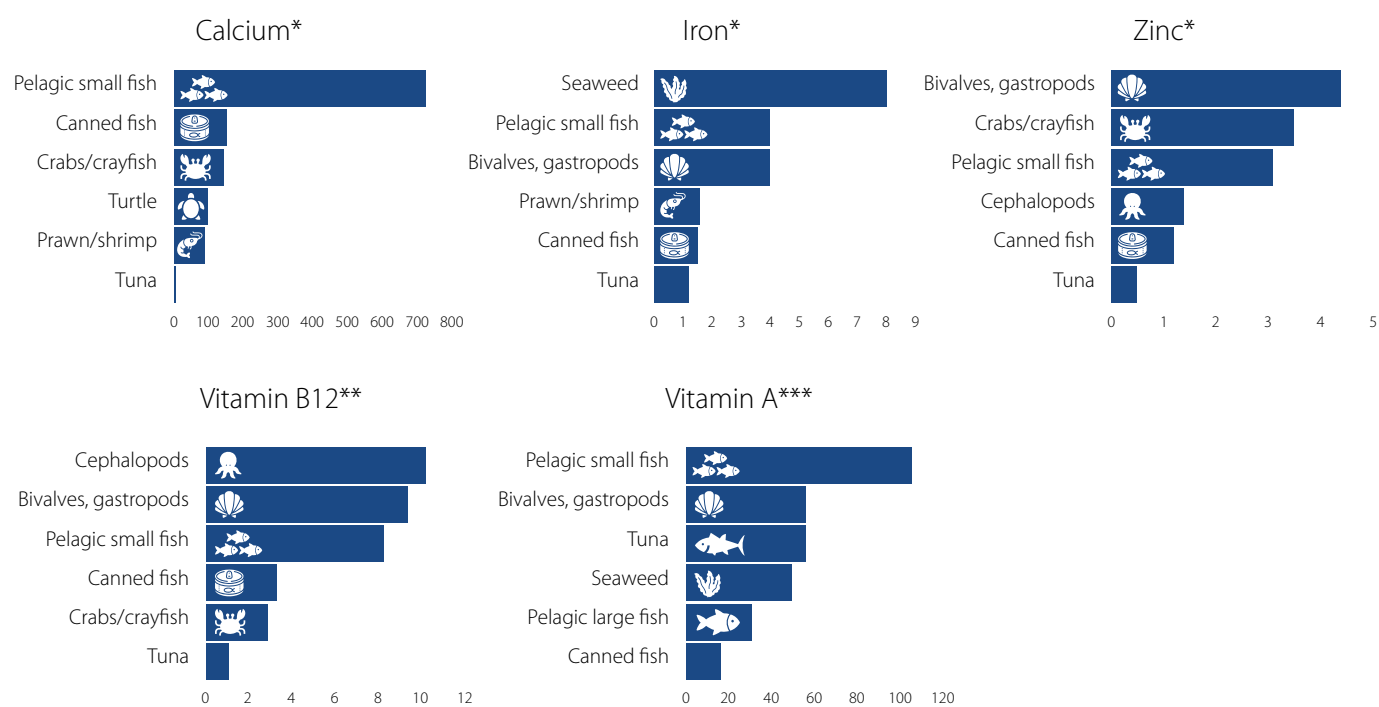
**Innovation:** Nearshore, anchored FADs are a technology that can reduce pressure on reefs and support the food and nutrition security of artisanal fishing communities by making oceanic fish stocks more accessible to coastal small-scale fishers (Bell *et al.*, 2009). As a result, FADs can protect the biodiversity of nearshore marine resources while improving the livelihoods and diets of small-scale fishers. There is ample evidence of the positive impacts FADs have on catch rates in the Pacific (Sharp, 2011).

Notes

Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. and Andréfouët, S. 2009. Planning the use of fish for food security in the Pacific. *Marine Policy* 33:64–76. doi: 10.1016/j.marpol.2008.04.002

Sharp, M. 2011. The benefits of fish aggregating devices in the Pacific. *SPC Fish Newsl.* Noumea, New Caledonia: SPC.

**Figure 3.** Micronutrient content of different fish and other aquatic foods in the Pacific Islands.



\*mg/100 g raw, edible parts, \*\*ug/100 g raw, edible parts, \*\*\*ug RAE/100 g raw, edible parts

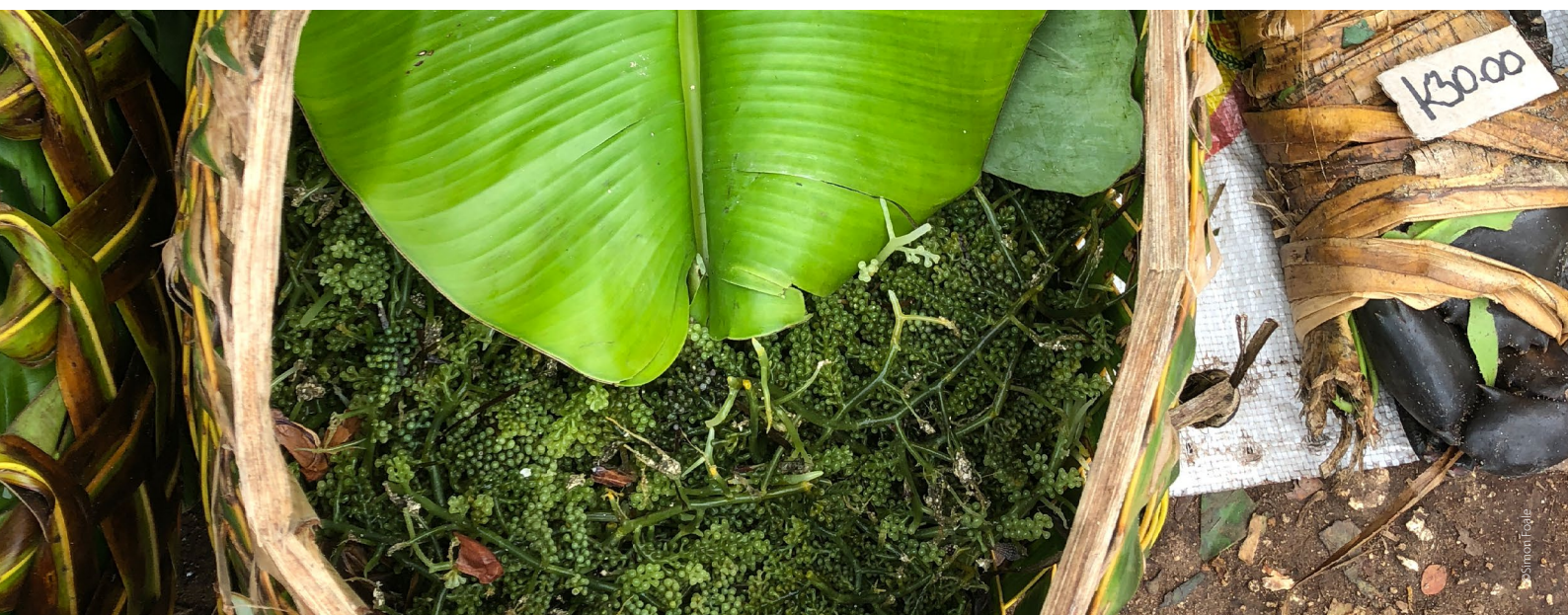
Source: Authors' elaboration.

## Recommendation 4: Raise awareness of the nutritional and health benefits of eating fish and other aquatic foods

**To slow or reverse the trend in declining fish consumption, it is critical for nutrition-sensitive initiatives to promote consumption of fish and other aquatic foods as part of an overall healthy diet because they are rich in easy-to-absorb micronutrients, omega-3 fatty acids and lean protein.**

For generations, the people of the Pacific Islands have benefited nutritionally from eating fish and other aquatic foods as part of a healthy traditional diet (Charlton *et al.*, 2016; SPC, 2018). These foods can reduce the incidence and likelihood of micronutrient deficiencies, diet-related noncommunicable diseases, thyroid conditions and cancer (Charlton *et al.*, 2016). In a recent assessment, Pacific Islander household diets had, on average, adequate levels of vitamin B12 because of the high rates of fish consumption in Samoa (FAO and SBS, 2020), Solomon Islands (FAO and SPC, 2021), Kiribati (KNSO *et al.*, 2021) and the Marshall Islands (EPPSO *et al.*, 2021). Moreover, in Solomon Islands vitamin B12 intake was more likely to be adequate and iron intake was highest in fishing households compared with the rest of the population, though anemia is still a public health concern in fishing communities, especially for women and children (FAO and SPC 2021).

In Samoa, adults who eat traditional diets based on local fish and other aquatic foods, roots and tubers, green leafy vegetables and fruits are less likely to develop inflammatory-related conditions such as obesity or type-2 diabetes compared to those who adopt western diets (DiBello *et al.* 2009). In part, this is likely because the anti-inflammatory effects of omega-3 fatty acids in fish and other aquatic foods are protective for heart health (Mozaffarian and Rimm, 2006; Del Gobbo *et al.*, 2016). Eating fish at least once or twice a week reduces the risk of coronary death by 36 percent and total mortality by 17 percent (Mozaffarian and Rimm, 2006). In French Polynesia, high consumption of fish, shellfish and cassava is also associated with lower risk of thyroid cancer (Cléro *et al.*, 2012a and 2012b). This demonstrates how the nutrients in fish and other aquatic foods make them an important part of dietary approaches to reduce the risk of diet-related, non-communicable diseases during the nutrition transition currently underway in the Pacific Islands (Box 4) (Bell *et al.*, 2009; Charlton *et al.*, 2016).



Seaweed and mud crabs for sale in a rural Pacific Island market.

#### Box 4. Nutrition education to increase consumer demand for local foods

It is important that nutrition-sensitive initiatives promote the health benefits of eating local traditional foods while simultaneously increasing supply (Barker, 2015). Although highly nutritious, some local foods can be overlooked because they are regarded as “low status” foods, are not preferred or are not recognized as sources of nutrition (Goebel *et al.*, 2014). In Solomon Islands, women reported eating only three out of 10 nutritious green leafy vegetables that were locally available (Albert *et al.*, 2020). In Kiribati, despite high food and nutrition insecurity, consumption of widely available seaweed was low (Butcher *et al.*, 2020) because people did not know which seaweed types are edible (Swanepoel *et al.*, 2020).

Celebrating local traditional foods through innovative public health campaigns has the potential to increase demand for locally produced foods (Cvitanovic *et al.* 2016; Vermeulen *et al.* 2019), increase supply and reduce loss and waste (Underhill *et al.*, 2017). Combined with effective monitoring, evaluation and adaptation, Behavior change communication interventions have also been shown to improve child feeding practices and nutritional status (Bhutta *et al.*, 2013; Ruel *et al.*, 2018).

**Innovation 1:** Nutrition education needs to take a whole village and household approach (O’Meara *et al.* forthcoming). Historically, nutrition education has focused on women. This has inadvertently increased the burden of responsibility women hold for both their own nutrition and other household members, which can worsen women’s well-being. Because of the influence that men have on village and household decisions, their nutrition knowledge could have a positive impact on maternal and child diet diversity. As such, it is important that all members of a household and community are included in nutrition education initiatives (Ambikapathi *et al.*, 2021).

**Innovation 2:** Practical food literacy skills are important to help more people eat nutritious local foods (PIFR, 2021). The Pacific Food Revolution is a region-wide project that aims to promote local healthy food through a reality television show that showcases Pacific Islanders cooking and demonstrating dishes, made with local foods, that are unique to their country and culture. This approach is working to develop the perception that local foods are “trendy,” with viewers from Tonga, Samoa, Vanuatu and Fiji reporting a shift in their diets toward more local foods in 2020 (AusAID and NZAid, 2021). Pacific Island viewers described an appreciation for practical skills such as the cooking techniques and recipes demonstrated on the show and the corresponding website.

Similar desires for practical recipe development and documentation were also highlighted in a recent seaweed value chain project in Kiribati (Swanepoel *et al.*, 2020). In places where fish consumption is high, like the Polynesian islands, nutrition education is also important, such as the Kiribati Fish for Life Campaign, to raise people’s awareness about the nutritional and health benefits of eating fish and other aquatic foods.

#### Notes

Albert, J., Bogard, J., Siota, F., McCarter, J., Diatalau, S., Maelaua, J., Brewer, T. and Andrew, N. 2020. Malnutrition in rural Solomon Islands: An analysis of the problem and its drivers. *Maternal and Child Nutrition* 16:1–12. doi: 10.1111/mcn.12921

[AusAID and NZAid] Australian Agency for International Development; New Zealand Agency for International Development. 2021. Highlights from the Pacific Island Food Revolution Year 3 Impact Assessment. Canberra, Australia: AusAID; Auckland, New Zealand: NZAid.

Barker, M. 2015. Developmental origins, behaviour change and the new public health. *Journal of Developmental Origins of Health and Disease* 6. doi: 10.1017/S2040174415001312

Bhutta, Z.A., Das, J.K., Rizvi, A., Gaffey, M.F., Walker, N., Horton, S., Webb, P., Lartey, A. and Black, R.E. 2013. Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *Lancet* 382:452–77. doi: 10.1016/S0140-6736(13)60996-4

Butcher, H., Burkhart, S., Paul, N., Titiij, U., Tamuera, K., Eria, T. and Swanepoel, L. 2020. Role of seaweed in diets of Samoa and Kiribati: Exploring key motivators for consumption. *Sustainability* 12. doi: 10.3390/SU12187356

Cvitanovic, C., Crimp, S., Fleming, A., Bell, J., Howden, M., Hobday, A.J., Taylor, M. and Cunningham, R. 2016. Linking adaptation science to action to build food secure Pacific Island communities. *Climate Risk Management* 11:53–62. doi: 10.1016/j.crm.2016.01.003

Goebel, R., Taylor, M. and Lyons, G. 2014. Feasibility study on increasing the consumption of nutritionally-rich leafy vegetables by indigenous communities in Samoa, Solomon Islands and Northern Australia. Canberra, Australia: Australian Centre for International Agricultural Research.

O’Meara, L., Williams, S., Mooney, J., Hickey, D. and Brown, P. Forthcoming. Food security of indigenous food-producing households: Gendered perspectives from rural Fiji.

Ruel, M.T., Quisumbing, A.R. and Balagamwala, M. 2018. Nutrition-sensitive agriculture: What have we learned so far? *Global Food Security* 17:128–53. doi: 10.1016/j.gfs.2018.01.002

Swanepoel, L., Tioti, T., Eria, T., Tamuera, K., Titiij, U., Larson, S. and Paul, N. 2020. Supporting women’s participation in developing a seaweed supply chain in Kiribati for health and nutrition. *Foods* 9. doi: 10.3390/foods9040382

Underhill, S.J.R., Zhou, Y., Sherzad, S., Singh-Peterson, L. and Tagoei, S.M. 2017. Horticultural postharvest loss in municipal fruit and vegetable markets in Samoa. *Food Security* 9:1373–83. doi: 10.1007/s12571-017-0734-7

Vermeulen, S., Park, T., Khoury, C., Mockshell, J., Béné, C., Thi, H., Heard, B. and Wilson, B. 2019. Changing diets and transforming food systems. CCAFS Working Paper no. 282. Wageningen, The Netherlands: CGIAR.

## Recommendation 5: Design nutrition-sensitive initiatives for women and also children during the first 1 000 days of life

### **Prioritize and target interventions in ways that increase consumption of fish and other aquatic foods in ways that prevent malnutrition among the most nutritionally vulnerable, especially for women and children.**

In the Pacific Islands, maternal and child undernutrition remains a major health concern, especially during the first 1 000 days of life (Box 5) (Victora *et al.*, 2021). Recently, the COVID-19 pandemic has exacerbated malnutrition, further deepening the socioeconomic inequalities that determine its prevalence. In women of reproductive age, high rates of anemia, which is a condition often related to low iron consumption, is found throughout the Pacific Islands and is slightly lower (30 percent) than the global average (32 percent) (Global Nutrition Report, 2020). Also, high rates of stunting are found in children under 5 years old in Papua New Guinea (50 percent), the Marshall Islands (35 percent), Solomon Islands (32 percent) and Vanuatu (29 percent) compared with the global average (21 percent). This is concerning because maternal and child malnutrition has profound lifelong and intergenerational consequences for individuals, communities and nations (Victora *et al.*, 2008 and 2021; Leroy *et al.*, 2020).

In Pacific Island nations, fish and other aquatic foods can help address nutritional deficiencies in both women and children (Figure 4) (Hicks *et al.*, 2019; Farmery *et al.*, 2020; Byrd *et al.*, 2021). One example

is the risk of stunting is lower when rates of fish consumption are high (Headey *et al.*, 2018; Marinda *et al.*, 2018). Another is the vital importance of omega-3 fatty acids in fish and other aquatic foods for healthy brain development. According to a large systematic review, women who ate 113 g or more of seafood per week during pregnancy gave birth to children with an average increase of 7.7 intelligence quotient points (Hibbeln *et al.*, 2019). Eating fish also improves the nutrient content of breastmilk, which is the source of nourishment for infants during the exclusive breastfeeding period from birth to 6 months of age (Kuipers *et al.*, 2005; Martin *et al.*, 2012; Yakes *et al.*, 2015; Fiorella *et al.*, 2018).

However, national averages of fish consumption mask inequities in the consumption and distribution of fish and other aquatic foods relative to nutritional need. The nutritional benefits of fish and other aquatic foods are not always reaching the most nutritionally vulnerable groups in Pacific Island nations, such as pregnant women, young children and infants (Albert *et al.*, 2020; Farmery *et al.*, 2020). For these groups, increasing fish consumption as part of a healthy diet will lead to better nutrition and health outcomes (Byrd *et al.*, 2022). Currently, diet quality in women and children is low in some Pacific Island nations, including Solomon Islands (Horseley *et al.*, 2019; Albert *et al.*, 2020; Farmery *et al.*, 2020), Vanuatu (Farmery *et al.*, 2020) and Kiribati (Eme *et al.*, 2019). Notably,



For sale at a rural Pacific Island market, diverse species of fish captured from coastal waters.

despite women in urban centres in Kiribati having higher dietary diversity, there were more nutrient deficiencies there than in rural populations because portion sizes of nutrient-rich foods, such as fresh fish, were insufficient to meet nutrient needs

(Eme *et al.*, 2020). This illustrates the limitation of diet indicators in correlating with nutrition status, and so there is still a need for better quantitative information on both dietary diversity and nutrient adequacy from diets (Albert and Bogard, 2015).

### Box 5. The first 1 000 days of life

The critical window of growth for a child occurs during gestation, exclusive breastfeeding and complementary feeding (Adu-Afarwuah *et al.*, 2017). During this time, the baby requires the highest ratio of nutrients per bodyweight compared with any other life stage (Dewey, 2013). If the child does not receive sufficient nutrients, permanent damage to cognition and growth can occur, and they can become stunted (Leroy *et al.*, 2020). Later, the child could struggle to do well at school and at work, reinforcing the cycle of poverty (Victora *et al.*, 2008). Maternal and child health are foundational to equitable and sustainable national development, and world leaders, including those in the Pacific Island nations, have committed to ending all forms of malnutrition (UN, 2015).

#### Notes

**Adu-Afarwuah, S., Lartey, A. and Dewey, K.G.** 2017. Meeting nutritional needs in the first 1000 days: A place for small-quantity lipid-based nutrient supplements. *Annals of the New York Academy of Sciences* 1392:18–29. doi: 10.1111/nyas.13328

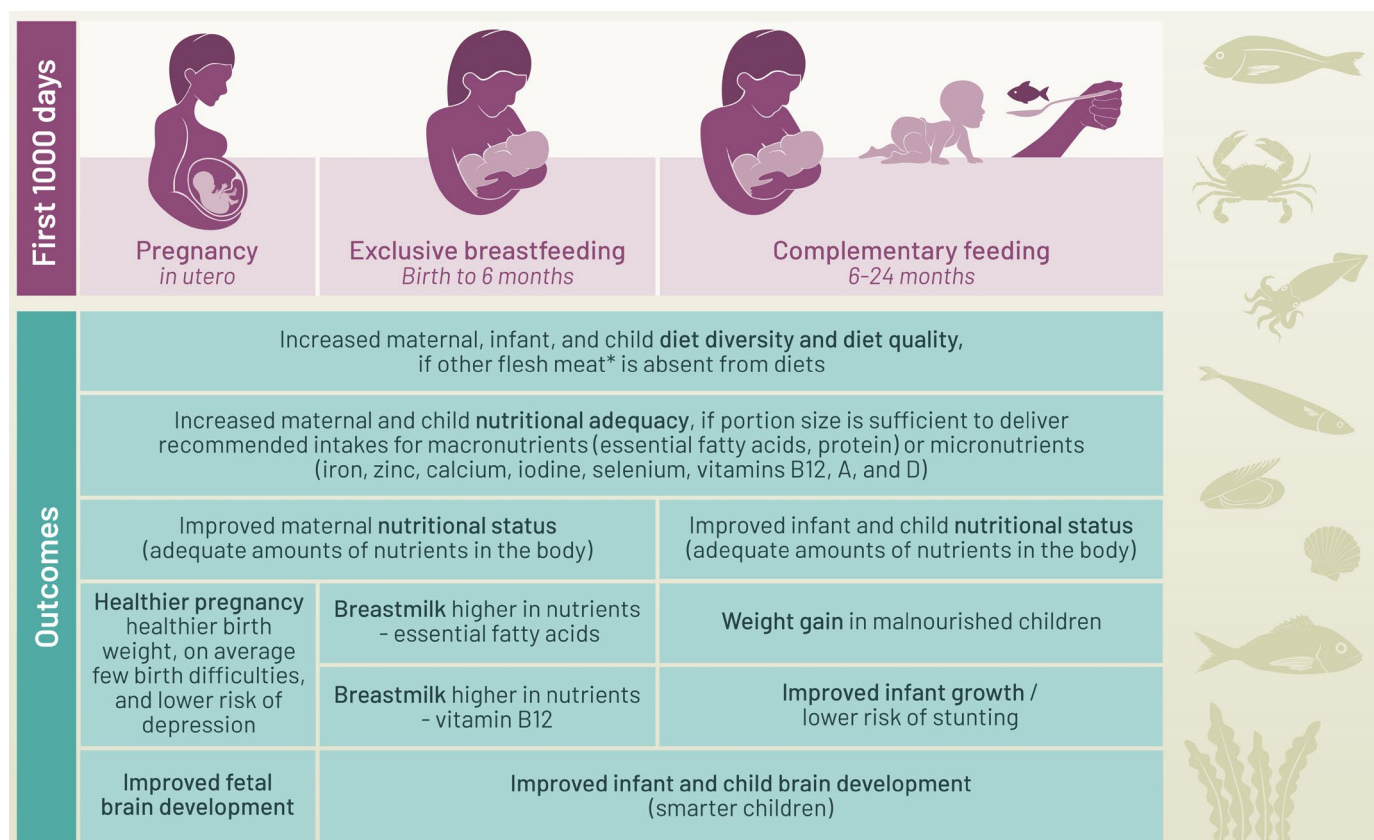
**Dewey, K.G.** 2013. The challenge of meeting nutrient needs of infants and young children during the period of complementary feeding: An evolutionary perspective. *Journal of Nutrition* 143:2050–54. doi: 10.3945/jn.113.182527

**Leroy, J.L., Frongillo, E.A., Dewan, P., Black, M.M. and Waterland, R.A.** 2020. Can children catch up from the consequences of undernourishment? Evidence from child linear growth, developmental epigenetics, and brain and neurocognitive development *Advances in Nutrition* 11:1032–41. doi: 10.1093/ADVANCES/NMAA020

[UN] **United Nations.** 2015. *Transforming our world: The 2030 Agenda for Sustainable Development.* New York: UN.

**Victora, C.G., Adair, L., Fall, C., Hallal, P.C., Martorell, R., Richter, L., Sachdev, H.S. and the Maternal and Child Undernutrition Study Group.** 2008. Maternal and child undernutrition: Consequences for adult health and human capital. *Lancet* 371:340–57. doi: 10.1016/S0140-6736(07)61692-4

**Figure 4.** Key stages of the first 1 000 days of life (from conception to when a child is two years of age), and the dietary, nutritional and health impacts from eating fish and other aquatic foods (strength of evidence for the impacts varies)



Source: Adapted with permission from Byrd, K., Shieh, J., Mork, S., O'Meara, L., Atkins, M., Pincus, L. and Thilsted, S. 2022. *Fish and fish-based products and nutrition and health in the first 1 000 days: A systematic review of the evidence from low and middle income countries.* doi: 10.1093/advances/nmac102

# Recommendation 6: Develop and deliver food preservation techniques appropriate for fish and other aquatic foods to fill seasonal, economic and geographic shortfalls

## **Develop fish supply chains and innovative fish-based products to reduce food loss and waste, increase shelf life, enhance distribution to inland communities, and fill seasonal food and nutrition insecurity gaps.**

The Pacific Island nations enjoy tropical weather year-round, with two seasons: a warm, humid period from November to April and a cool, dry period from May to October. Subsistence fishers generally fish several times a week and often consume or sell their catch to other community members on the day it is caught. During unfavorable weather events or fishing bans, a lack of cold storage because of poor infrastructure and expensive electricity can lead to seasonal food insecurity (WFP, 2016).

Moreover, external shocks such as COVID-19-related mobility restrictions have exacerbated challenges faced in accessing fish (Box 6) (SPC, 2021; Ferguson *et al.*, 2022). This highlights the need to focus on enhancing storage, processing and distribution of local foods to improve food and nutrition security (Farrell *et al.*, 2020). Reducing fish loss and waste by developing

supply chains and infrastructure, as well as innovations in cold chain technologies, processing and storage facilities, can improve fish availability while contributing to nutritional quality (Box 7) (Thilsted *et al.*, 2016).

Some researchers have suggested increasing consumption of offshore fish (including in canned forms) relative to coastal fisheries might alleviate pressure from nearshore ecosystems (Bell *et al.*, 2009). The concern is that shifting diets from a diversity of aquatic foods to just one can lead to a decline in diet quality, even if fish consumption rates are maintained or even increased (Bogard *et al.*, 2016). Therefore, it is important that Pacific Island food systems also preserve a diversity of fish and other aquatic foods and increase equitable distribution to vulnerable populations, such as those inland.

There is substantial potential to increase knowledge of how fish and fish-based products circulate between and among local regions, and the factors that influence fish distribution. This understanding could illuminate opportunities to extend fish distribution to those who do not have adequate access to fish (SPC, 2015).

### **Box 6. Resilience to shocks and learning from the COVID-19 pandemic**

Over the years, the Pacific Island food system has become increasingly vulnerable to shocks (Farrell *et al.*, 2020). Worryingly, the effect of the COVID-19 pandemic on local incomes and remittances means that some families struggle to afford imported foods (Eriksson *et al.*, 2020; Farrell *et al.*, 2020; Sutcliffe *et al.* n.d.). Moreover, mobility restrictions and curfews associated with the pandemic have decreased or, in some cases, cut the amount of time fishers can be at sea in half, further exacerbating household food insecurity (Lau *et al.*, 2020; Sutcliffe *et al.* n.d.). During the early days of the pandemic, many Pacific Island countries distributed seeds and encouraged families to plant kitchen gardens to promote food self-sufficiency (Sherzad, 2020). Some countries also provided technical advice on low-cost options for solar drying vegetables to make cassava flour and dark green leafy vegetable powders (FAO, 2020b).

During the COVID-19 pandemic, which disrupted food supply chains, recent research has shown how important local farms and fisheries were for providing nutritious food for Pacific Islanders (Ferguson *et al.*, 2022). However, complete reliance on subsistence or local food sources can threaten food security, as demonstrated by the importance of imports to fill temporary food shortages when cyclones destroy local food crops (WFP, 2016; Ferguson *et al.*, 2022). This highlights the importance of harnessing the synergistic effect of long and short supply chains to ensure food system resilience and food and nutrition security during future shocks.



## Continuing Box 6

### Notes

**Eriksson, H., Ride, A., Boso, D., Sukulu, M., Batalofo, M., Siota, F. and Gomese, C.** 2020. *Changes and adaptations in village food systems in Solomon Islands: A rapid appraisal during the early stages of the COVID-19 pandemic*. Honiara, Solomon Islands: WorldFish.

**[FAO] Food and Agriculture Organization.** 2020b. *Preserve your own food: Promoting healthy eating through home food processing and preservation*. Rome: FAO.

**Farrell, P., Thow, A.M., Wate, J.T., Nonga, N., Vatucawaqa, P., Brewer, T., Sharp, M.K., Farmery, A., Trevena, H., Reeve, E.** 2020. COVID-19 and Pacific food system resilience: Opportunities to build a robust response. *Food Security* 12:783–91. doi: 10.1007/s12571-020-01087-y

**Ferguson, C.E., Tuxson, T., Mangubhai, S., Jupiter, S., Govan, H., Bonito, V., Alefaio, S., Anjiga, M., Booth, J., Boslogo, T.** 2022. Local practices and production confer resilience to rural Pacific food systems during the COVID-19 pandemic. *Marine Policy* 137:104954.

**Lau, J., Sutcliffe, S. and Hungito, W.** 2020. *Lived experiences of Covid-19: Impacts on an atoll island community, Papua New Guinea*. Townsville, Australia: James Cook University.

**Sherzad, S.** 2020. *Impacts of COVID-19 on the food systems in the Pacific small island developing states (PSIDS) and a look into the PSIDS responses*. Rome: FAO. 1–15.

**Sutcliffe, S., Lau, J., Barnes, M., Mbaru, E., Wade, E., Muthiga, N., Hungito, W., Muly, I., Wanyonyi, S. and Cinner, J.** In review. *COVID-19 policy impact pathways and feedbacks: A food systems analysis in small-scale fishing communities*.

**[WFP] World Food Programme.** 2016. *Tropical Cyclone Winston food security and livelihoods recovery needs assessment*. Suva, Fiji: WFP.

## Box 7. Low-cost methods to preserve fish

**Innovation:** Low-cost capture fisheries and preservation methods can help fill food and nutrition security gaps. This is particularly important in contexts where food scarcity is widespread and cyclical. Seasonal shortages would benefit from improvements in processing methods such as fish drying and smoking, which not only preserve but also concentrate nutrient contents (Byrd *et al.*, 2021). In Kiribati and the Marshall Islands, for example, traditional fish drying practices could be fostered to promote household food and nutrition security and develop innovative fish-based products, such as tuna jerky or fish sausages (FAO, 2021b). Preserving fish in reusable jars has also been trialed. This method can be less expensive and have a lower environmental footprint than home-canning fish, though the process could introduce large amounts of sugar, salt or preserving agents (FAO, 2021b). Although fish drying might not be as common in other Pacific Island nations, promoting low-cost jarring or homemade solar drying options could be key strategies for promoting low-cost, hygienic preservation options (FAO, 2020b). In some villages, community-controlled fish storage, like a community freezer, might help. However, it is important that such an option be solar-powered to eliminate reliance on electricity, which can be expensive.

### Notes

**Byrd, K.A., Thilsted, S.H. and Fiorella, K.J.** 2021. Fish nutrient composition: A review of global data from poorly assessed inland and marine species. *Public Health Nutrition* 24:476–86.

**[FAO] Food and Agriculture Organization.** 2020b. *Preserve your own food: Promoting healthy eating through home food processing and preservation*. Rome: FAO.

**[FAO] Food and Agriculture Organization.** 2021b. *Poverty, malnutrition and food security in Pacific Small Island Developing States*. Bangkok: FAO.

## Box 8. Canned fish

Pacific Islanders are increasingly eating more canned fish (FAO and SPC, 2021) because of urbanization, changing preferences, lack of refrigeration, and constraints on women's use of time (Albert *et al.*, 2020). In areas with limited opportunities to fish or grow crops, canned fish is important for food and nutrition security (Charlton *et al.*, 2016). In places where drinking milk is low, canned fish is also a good source of calcium, especially if it is a small species that can be consumed whole with the bones. However, the nutritional value of canned fish varies widely because of added ingredients like salt, sugar and oil. To ensure the health of Pacific Islanders, it is important to provide canned fish products that align with acceptable levels of added ingredients, as per the Pacific Dietary Guidelines (SPC, 2018). Moreover, high trophic level pelagic fish often contain mercury, which can have negative effects on the brain development of a fetus. In general, it is safe for a pregnant woman to eat two to three servings per week of these fish, such as shark, swordfish or tuna (FSANZ, 2014). This is especially so if the species (e.g. tuna) is also high in omega-3 fatty acids, which are anti-inflammatory and help offset the oxidative effect of mercury (Strain *et al.*, 2015).

### Notes

**Albert, J., Bogard, J., Siota, F., McCarter, J., Diatalau, S., Maelaua, J., Brewer, T. and Andrew, N.** 2020. Malnutrition in rural Solomon Islands: An analysis of the problem and its drivers. *Maternal and Child Nutrition* 16:1–12. doi: 10.1111/mcn.12921

**Charlton, K.E., Russell, J., Gorman, E., Hanich, Q., Delisle, A., Campbell, B. and Bell, J.** 2016. Fish, food security and health in Pacific Island countries and territories: A systematic literature review. *BMC Public Health* 16. doi: 10.1186/s12889-016-2953-9

**[FAO and SPC] Food and Agriculture Organization; the Pacific Community.** 2021. *Food consumption in Solomon Islands*. Honiara, Solomon Islands: FAO and SPC.

**[FSANZ] Food Standards Australia New Zealand.** 2014. *FSANZ advice on fish consumption*. Wellington, New Zealand: FSANZ.

**[SPC] Pacific Community.** 2018. *Pacific guidelines for healthy living: A handbook for health professionals and educators*. Noumea, New Caledonia: SPC.

**Strain, J.J., Yeates, A.J., Van Wijngaarden, E., Thurston, S.W., Mulhern, M.S., McSorley, E.M., Watson, G.E., Love, T.M., Smith, T.H. and Yost, K.** 2015. Prenatal exposure to methyl mercury from fish consumption and polyunsaturated fatty acids: Associations with child development at 20 mo of age in an observational study in the Republic of Seychelles. *American Journal of Clinical Nutrition* 101:530–37. doi: 10.3945/ajcn.114.100503

## Recommendation 7: Strengthen trade and supply chains toward nutrition outcomes

### **Assess the nutrient flow of imported and exported food products and the effect on the health of food environments. Retain fish and other aquatic foods for local consumption, and develop intraregional supply chains to ensure equitable distribution to all Pacific Islanders.**

Global trade can distribute more diverse foods at lower prices, but this does not always result in improved food and nutrition security or diet quality in certain contexts (Béné *et al.*, 2010; McCorrison *et al.*, 2013). Indeed, import dependent markets in the Pacific Islands region have resulted in unhealthy market-based food environments, driving increased consumption of highly processed foods (Evans *et al.*, 2003; Burkhart *et al.*, 2021; O'Meara *et al.*, forthcoming). Moreover, diet quality in some Pacific Island contexts appears to be higher among rural, subsistence-based households that have access to land to grow food, and coastal communities with access to traditional fishing grounds (O'Meara *et al.*, 2019; Bogard *et al.*, 2021) compared with urban populations that depend on markets.

During nutrition transitions, replacing traditional foods with poor quality imported foods is avoidable. In the Maldives, for example, trade regulations and food policy interventions have restricted imports of Western food (WHO, 2017a), and it appears to have supported a more balanced

diet of local foods in the country supplemented with high quality imported foods. This could have contributed to its lower rates of cardiovascular diseases per capita compared with other small island developing states that embraced trade liberalization (Golden *et al.*, 2021a). In addition to policy interventions, an important element in making a positive dietary transition is harnessing the energy, creativity and moral force of grassroots movements, such as extended kinship networks, traditional leaders, churches, municipal authorities or diaspora networks.

Transformation of food systems should not suggest or lead to loss of traditional practices. Innovations can be reassertions of earlier, potentially better adapted institutions and technologies, such as local management of fisheries, and growing root crops that survive cyclones and saline water intrusions, as well as diverse multi-tiered agroforestry systems (Andrew *et al.*, 2021).

Although Solomon Islands' tuna cannery does distribute locally canned tuna within the Pacific Island region (IFC, 2016), much of the local canned fish is traded to high-income countries for monetary value (Gillett and Tauati, 2018). From a public health perspective, this is problematic because it means that local, nutritious fish, like South Pacific tuna, are traded out of



Fish and fresh produce at the market in Kavieng, the urban centre of New Ireland Province in Papua New Guinea.

the region while less expensive, nutritionally poor foods, such as noodles and white flour, are imported. This results in a “nutrient trade deficit” (Hicks *et al.*, 2019; Nash *et al.*, 2022) while also increasing the environmental footprint of the global food system (Béné *et al.*, 2010).

Although some Polynesian islands rely heavily on income from leasing the high seas to international fishing companies (Gillett and Tauati, 2018), the sale of fish does not always result in improved nutrition outcomes for local fishing households (Béné *et al.*, 2010). This is especially so when poor quality imports saturate market-based food environments (Thow *et al.*, 2011; Bogard *et al.*, 2021; Burkhart *et al.*, 2021). Some outward sale of fish might be necessary to ensure that government is able to provide essential public services like healthcare and education, which are

important upstream determinants of nutrition and health. However, it is also important to ensure that sufficient fish is retained for local consumption (Béné *et al.*, 2010; Hicks *et al.*, 2019; Golden *et al.*, 2021a; Nash *et al.*, 2022).

Compared with nutrition and climate change commitments, which are voluntary, trade policies controlling exports and imports, and taxes on low quality foods are legally binding, making them a strong instrument to leverage change within food environments (Box 9) (Friel *et al.*, 2020). This highlights how important it is for the Pacific Islands to implement import standards to reduce the influx of highly processed, nutrient-poor foods, while simultaneously supporting local production and intraregional trade among Pacific Island nations (Thow *et al.*, 2011 and 2014; Golden *et al.*, 2021a).

### Box 9. Making good use of taxes and subsidies

If regulated effectively, government taxes and subsidies have the potential to build healthier food environments in the Pacific Islands (Burkhart *et al.*, 2021). For example, taxing negative externalities can serve as double-duty fiscal policies to reduce environmental footprints while raising revenue to fund policies that promote nutrition and health (WHO, 2017b).

Fiscal policies, especially in small island low- and middle-income countries, must be carefully considered and monitored, as subsidies for economic development can be inefficient, costly and inadvertently encourage exploitation of natural resources, leading to negative environmental impacts (Anglada *et al.* 2019). However, these countries need to be considered differently, compared with large land-based continents, because of their unique vulnerabilities and capacity constraints (UN, 2014). The numerous development challenges that such countries face are compounded by very small tax bases because of (i) disproportionately small population sizes relative to geographical coverage, (ii) constrained economies of scale, and (iii) relatively expensive public administration and infrastructure (UN, 2021). Although Pacific Island nations have a high environmental consciousness, there is a gap between ideal goals and what they can finance using existing public funds (UN, 2014).

**Innovation:** Careful development of “green” policies that are used to safeguard human and planetary health may need to be considered (Anglada *et al.*, 2019). In the past decade, two-thirds of Pacific Island nations have implemented taxes on sugar-sweetened beverages (Teng *et al.*, 2021); however, policies could be strengthened by expanding them to include taxes on other unhealthy imported products, with the revenue used to subsidize the price of local, nutritious foods such as fruits, vegetables, and fish and other aquatic foods (WHO, 2017b).

#### Notes

**Anglada, C., Binet, T., Murray, K. and Wyatt, S.** 2019. *Analysis of taxes and subsidies relevant to Pacific Ocean health*. Auckland, New Zealand: Sapere Research Group and VertigoLab.

**Burkhart, S., Craven, D., Horsey, B., Perry, J., O’Connell, T. and Underhill, S.** 2021. *The role of diets and food systems in the prevention of obesity and non-communicable diseases in Fiji*. Apia, Samoa: FAO.

**Teng, A., Snowdon, W., Win Tin, S.T., Genç, M., Na’ati, E., Puloka, V., Signal, L. and Wilson, N.** 2021. Progress in the Pacific on sugar-sweetened beverage taxes: A systematic review of policy changes from 2000 to 2019. *Australian and New Zealand Journal of Public Health* 45(4):376–84. doi: 10.1111/1753-6405.13123.

**[UN] United Nations.** 2014. *Third International Conference on Small Island Developing States the outcome of which was the SIDS Accelerated Modalities of Action Pathway, commonly known as the SAMOA Pathway*. Apia, Samoa. September 1–4, 2014.

**[UN] United Nations.** 2021. *The UN Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States*. New York, UN: Accessed September 24, 2021. <https://www.un.org/ohrls/>

**[WHO] World Health Organization.** 2017b. *Tackling NCDs “best buys” and other recommended interventions for the prevention and control of noncommunicable diseases*. Geneva: WHO.

# Bibliography

---

- Adu-Afarwuah, S., Lartey, A. and Dewey, K.G.** 2017. Meeting nutritional needs in the first 1000 days: A place for small-quantity lipid-based nutrient supplements. *Annals of the New York Academy of Sciences* 1392:18–29. doi: 10.1111/nyas.13328
- Ahern, M., Thilsted, S., Oenema, S. and Kühnhold, H.** 2021. The role of aquatic foods in sustainable healthy diets. UN Nutrition Discussion Paper. Rome: UN.
- Albert, J. and Bogard, J.R.** 2015. Planning a nutrition-sensitive approach to aquatic agricultural systems research in Solomon Islands. CGIAR Research Program on Aquatic Agricultural Systems. AAS-2015-1. 1–20.
- Albert, J., Bogard, J., Siota, F., McCarter, J., Diatalau, S., Maelaua, J., Brewer, T. and Andrew, N.** 2020. Malnutrition in rural Solomon Islands: An analysis of the problem and its drivers. *Maternal and Child Nutrition* 16:1–12. doi: 10.1111/mcn.12921
- Albert, J.A., Beare, D., Schwarz, A.M., Albert, S., Warren, R., Teri, J., Siota, F. and Andrew, N.L.** 2014. The contribution of nearshore fish aggregating devices (FADs) to food security and livelihoods in Solomon Islands. *PLOS ONE* 9:1–19. doi: 10.1371/journal.pone.0115386
- Alva, S., Johnson, K., Jacob, A., D’Agnes, H., Mantovani, R. and Evans, T.** 2016. Marine protected areas and children’s dietary diversity in the Philippines. *Population and Environment* 37:341–61. doi: 10.1007/s11111-015-0240-9
- Ambikapathi, R., Passarelli, S., Madzorera, I., Canavan, C.R., Noor, R.A., Abdelmenan, S., Tewahido, D., Tadesse, A.W., Sibanda, L., Sibanda, S. et al.** 2021. Men’s nutrition knowledge is important for women’s and children’s nutrition in Ethiopia. *Maternal and Child Nutrition* 17:1–13.
- Andrew, N.L., Allison, E.H., Brewer, T., Connell, J., Eriksson, H., Eurich, J.G., Farmery, A., Gephart, J.A., Golden, C.D., Herrero, M. and Mapusua, K.** 2022. Continuity and change in the contemporary Pacific food system. *Global Food Security* 32:100608. doi: 10.1016/j.gfs.2021.100608.
- Andrew, N.L., Bright, P., de la Rua, L., Teoh, S.J. and Vickers, M.** 2019. Coastal proximity of populations in 22 Pacific Island Countries and Territories. *PLOS ONE* 14:1–15. doi: 10.1371/journal.pone.0223249
- Andrew, N., Campbell, B., Delisle, A., Li, O., Neihapi, P., Nikiari, B., Sami, A., Steenbergen, D. and Uriam, T.** 2020. Developing participatory monitoring of community fisheries in Kiribati and Vanuatu. *Fisheries Newsletter* 32–38.
- Anglada, C., Binet, T., Murray, K. and Wyatt, S.** 2019. Analysis of taxes and subsidies relevant to Pacific Ocean health. Auckland, New Zealand: Sapere Research Group and VertigoLab.
- [AusAID and NZAid] Australian Agency for International Development; New Zealand Agency for International Development.** 2021. Highlights from the Pacific Island Food Revolution Year 3 Impact Assessment. Canberra, Australia: AusAID; Auckland, New Zealand: NZAid.
- Barker, M.** 2015. Developmental origins, behaviour change and the new public health. *Journal of Developmental Origins of Health and Disease* 6. doi: 10.1017/S2040174415001312
- Bell, J.D., Kronen, M., Vunisea, A., Nash, W.J., Keeble, G., Demmke, A., Pontifex, S. and Andréfouët, S.** 2009. Planning the use of fish for food security in the Pacific. *Marine Policy* 33:64–76. doi: 10.1016/j.marpol.2008.04.002
- Bell, J.D., Reid, C., Batty, M.J., Lehodey, P., Rodwell, L., Hobday, A.J., Johnson, J.E. and Demmke, A.** 2013. Effects of climate change on oceanic fisheries in the tropical Pacific: Implications for economic development and food security. *Climate Change* 119:199–212. doi: 10.1007/s10584-012-0606-2
- Bell, J.D., Albert, J., Andréfouët, S., Andrew, N.L., Blanc, M., Bright, P., Brogan, D., Campbell, B., Govan, H., Hampton, J. et al.** 2015. Optimising the use of nearshore fish aggregating devices for food security in the Pacific Islands. *Marine Policy* 56:98–105.
- Belton, B., Reardon, T. and Zilberman, D.** 2020. Sustainable commoditization of seafood. *Nature Sustainability* 3:677–84. doi: 10.1038/s41893-020-0540-7
- Béné, C.** 2020. Resilience of local food systems and links to food security – A review of some important concepts in the context of COVID-19 and other shocks. *Food Security* 12:805–22. doi: 10.1007/s12571-020-01076-1
- Béné, C., Lawton, R. and Allison, E.H.** 2010. “Trade matters in the fight against poverty”: Narratives, perceptions, and (lack of) evidence in the case of fish trade in Africa. *World Development* 38:933–54. doi: 10.1016/j.worlddev.2009.12.010

- Bennett, A., Basurto, X., Viridin, J., Lin, X., Betances, S.J., Smith, M.D., Allison, E.H., Best, B.A., Brownell, K.D., Campbell, L.M. et al.** 2021. Recognize fish as food in policy discourse and development funding. *Ambio* 50:981–89. doi: 10.1007/s13280-020-01451-4
- Bernhardt, J.R. and O'Connor, M.I.** 2021. Aquatic biodiversity enhances multiple nutritional benefits to humans. *Proceedings of the National Academy of Sciences of the United States of America* 118:1–11. doi: 10.1073/pnas.1917487118
- Bhutta, Z.A., Das, J.K., Rizvi, A., Gaffey, M.F., Walker, N., Horton, S., Webb, P., Lartey, A. and Black, R.E.** 2013. Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *Lancet* 382:452–77. doi: 10.1016/S0140-6736(13)60996-4
- Bogard, J.R., Marks, G.C., Mamun, A. and Thilsted, S.H.** 2016. Non-farmed fish contribute to greater micronutrient intakes than farmed fish: Results from an intra-household survey in rural Bangladesh. *Public Health Nutrition* 20:702–11. doi: 10.1017/S1368980016002615
- Bogard, J.R., Andrew, N.L., Farrell, P., Herrero, M., Sharp, M.K. and Tutuo, J.** 2021. A typology of food environments in the Pacific region and their relationship to diet quality in Solomon Islands. *Foods* 10(11):2592.
- Bonis-Profumo, G., McLaren, R. and Fanzo, J.** 2019. Ravaged landscapes and climate vulnerability: The challenge in achieving food security and nutrition in post-conflict Timor-Leste. In Barling D and Fanzo J, eds. *Advances in Food Security and Sustainability*. Oxford: Elsevier.
- Bonis-Profumo, G., Stacey, N. and Brimblecomb, J.** 2021a. Maternal diets matter for children's dietary quality: Seasonal dietary diversity and animal-source foods consumption in rural Timor-Leste. *Maternal and Child Nutrition* 17:e13071.
- Bonis-Profumo, G., Stacey, N. and Brimblecomb, J.** 2021b. Measuring women's empowerment in agriculture, food production, and child and maternal dietary diversity in Timor-Leste. *Food Policy* 102:102102.
- Brodie, G., Pikacha, P. and Tuiwawa, M.** 2013. Biodiversity and conservation in the Pacific Islands: Why are we not succeeding? In Sodhi NS, Gibson L and Raven PH, eds. *Conservation Biology: Voices from the Tropic*. 182–87. doi: 10.1002/9781118679838.ch21
- Brugere, C., Troell, M. and Eriksson, H.** 2021. More than fish: Policy coherence and benefit sharing as necessary conditions for equitable aquaculture development. *Marine Policy* 123:104271. doi: 10.1016/j.marpol.2020.104271
- Burkhart, S., Craven, D., Horsey, B., Perry, J., O'Connell, T. and Underhill, S.** 2021. The role of diets and food systems in the prevention of obesity and non-communicable diseases in Fiji. Apia, Samoa: FAO.
- Butcher, H., Burkhart, S., Paul, N., Tiitii, U., Tamuera, K., Eria, T. and Swanepoel, L.** 2020. Role of seaweed in diets of Samoa and Kiribati: Exploring key motivators for consumption. *Sustainability* 12. doi: 10.3390/SU12187356
- Byrd, K., Shieh, J., Mork, S., Atkins, M., Pincus, L. and Thilsted, S.** 2022. Fish and fish-based products and nutrition and health in the first 1,000 days: A systematic review of the evidence from low and middle income countries. *Advances in Nutrition* 13(6):2458–87. doi: 10.1093/advances/nmac102
- Byrd, K.A., Thilsted, S.H. and Fiorella, K.J.** 2021. Fish nutrient composition: A review of global data from poorly assessed inland and marine species. *Public Health Nutrition* 24:476–86. doi: 10.1017/S1368980020003857
- Campbell, J.R.** 2020. Development, global change and food security in Pacific Island Countries. In Connell J and Lowitt K, eds. *Food Security in Small Island States*. Singapore: Springer. doi: 10.1007/978-981-13-8256-7\_3
- Charlton, K.E., Russell, J., Gorman, E., Hanich, Q., Delisle, A., Campbell, B. and Bell, J.** 2016. Fish, food security and health in Pacific Island countries and territories: A systematic literature review. *BMC Public Health* 16. doi: 10.1186/s12889-016-2953-9
- Cisneros-Montemayor, A.M., Pauly, D., Weatherdon, L.V. and Ota, Y.** 2016. A global estimate of seafood consumption by coastal indigenous peoples. *PLOS ONE* 11:1–16. doi: 10.1371/journal.pone.0166681
- Clark, M.A., Springmann, M., Hill, J. and Tilman, D.** 2019. Multiple health and environmental impacts of foods. *Proceedings of the National Academy of Sciences of the United States of America* 116:23357–362. doi: 10.1073/pnas.1906908116
- Cléro, É., Doyon, F., Chungue, V., Rachédi, F., Boissin, J.L., Sebbag, J., Shan, L., Bost-Bezeaud, F., Petitdidier, P., Dewailly, É. et al.** 2012a. Dietary iodine and thyroid cancer risk in French Polynesia: A case-control study. *Thyroid* 22:422–29. doi: 10.1089/thy.2011.0173

- Cléro, É., Doyon, F., Chungue, V., Rachédi, F., Boissin, J.L., Sebbag, J., Shan, L., Rubino, C. and De Vathaire, F.** 2012b. Dietary patterns, goitrogenic food, and thyroid cancer: A case-control study in French Polynesia. *Nutrition and Cancer* 64:929–36. doi: 10.1080/01635581.2012.713538
- Cohen, P.J., Lawless, S., Dyer, M., Morgan, M., Saeni, E., Teioli, H. and Kantor, P.** 2016. Understanding adaptive capacity and capacity to innovate in social-ecological systems: Applying a gender lens. *Ambio* 45:309–21. doi: 10.1007/s13280-016-0831-4
- Cohen, P.J., Allison, E.H., Andrew, N.L., Cinner, J., Evans, L.S., Fabinyi, M., Garces, L.R., Hall, S.J., Hicks, C.C., Hughes, T.P. et al.** 2019. Securing a just space for small-scale fisheries in the blue economy. *Frontiers in Marine Science* 6:1–8. doi: 10.3389/fmars.2019.00171
- Consalez, F., Ahern, M., Andersen, P. and Kjellevold, M.** 2022. The effect of the meat factor in animal-source foods on micronutrient absorption: A scoping review. *Advances in Nutrition* 13(6):2305–15. doi: 10.1093/advances/nmac089
- Cvitanovic, C., Crimp, S., Fleming, A., Bell, J., Howden, M., Hobday, A.J., Taylor, M. and Cunningham, R.** 2016. Linking adaptation science to action to build food secure Pacific Island communities. *Climate Risk Management* 11:53–62. doi: 10.1016/j.crm.2016.01.003
- Datta, R.** 2021. Community-led food resilience: A decolonizing autographic learning from an Inuit community. *Global Food Security* 30:100564. doi: 10.1016/j.gfs.2021.100564
- Del Gobbo, L.C., Imamura, F., Aslibekyan, S., Marklund, M., Virtanen, J.K., Wennberg, M., Yakoob, M.Y., Chiuve, S.E., Dela Cruz, L. and Frazier-Wood, A.C.** 2016.  $\Omega$ -3 polyunsaturated fatty acid biomarkers and coronary heart disease: Pooling project of 19 cohort studies. *JAMA Internal Medicine* 176:1155–66. doi: 10.1001/jamainternmed.2016.2925
- Dewey, K.G.** 2013. The challenge of meeting nutrient needs of infants and young children during the period of complementary feeding: An evolutionary perspective. *Journal of Nutrition* 143:2050–54. doi: 10.3945/jn.113.182527
- DiBello, J.R., McGarvey, S.T., Kraft, P., Goldberg, R., Campos, H., Qusted, C., Laumoli, T.S. and Baylin, A.** 2009. Dietary patterns are associated with metabolic syndrome in adult Samoans. *Journal of Nutrition* 139:1933–43. doi: 10.3945/jn.109.107888
- Downs, S.M., Ahmed, S., Fanzo, J. and Herforth, A.** 2020. Food environment typology: Advancing an expanded definition, framework, and methodological approach for improved characterization of wild, cultivated, and built food environments toward sustainable diets. *Foods* 9:532. doi: 10.3390/foods9040532
- Duarte, A., Hunnam, K.J. and Eriksson, H.** 2020. Cooking fish and seafood in Timor-Leste: Recipes and stories of traditions and livelihoods (Te' in ikan no hahán tasi iha Timor-Leste: Reseita ho istória sira kona-ba tradisaun no moris loroloron nian). Canberra, Australia: ACIAR.
- Eme, P.E., Burlingame, B., Douwes, J., Kim, N. and Foliaki, S.** 2019. Quantitative estimates of dietary intake in households of South Tarawa, Kiribati. *Asia Pacific Journal of Clinical Nutrition* 28:131–38. doi: 10.6133/apjcn.201903\_28(1).0018
- Eme, P.E., Kim, N.D., Douwes, J., Burlingame, B., Foliaki, S. and Wham, C.** 2020. Are households in Kiribati nutrition secure? A case study of South Tarawa and Butaritari. *Food and Nutrition Bulletin* 41:131–46. doi: 10.1177/0379572119891024
- [EPPSO, FAO, SPC] Economic Policy Planning and Statistics Office; Food and Agriculture Organization; Pacific Community.** 2021. Marshall Islands food security profile. Majuro, Marshall Islands: EPPSO; Rome: FAO; Noumea, New Caledonia: SPC.
- Eriksson, H., Adhuri, D.S., Adrianto, L., Andrew, N.L., Apriliani, T., Daw, T., Evans, L., Garces, L., Kamanyi, E., Mwai-popo, R. et al.** 2016. An ecosystem approach to small-scale fisheries through participatory diagnosis in four tropical countries. *Global Environmental Change* 36:56–66. doi: 10.1016/j.gloenvcha.2015.11.005
- Eriksson, H., Ride, A., Boso, D., Sukulu, M., Batalofo, M., Siota, F. and Gomese, C.** 2020. Changes and adaptations in village food systems in Solomon Islands: A rapid appraisal during the early stages of the COVID-19 pandemic. Honiara, Solomon Islands: WorldFish.

- Eriksson, H., Blythe, J.L., Österblom, H. and Olsson, P.** 2021. Beyond social-ecological traps: Fostering transformations towards sustainability. *Ecology and Society* 26. doi: 10.5751/ES-12198-260113
- Evans, M., Sinclair, R.C., Fusimalohi, C., Laiva'a, V. and Freeman, M.** 2003. Consumption of traditional versus imported foods in Tonga: Implications for programs designed to reduce diet-related non-communicable diseases in developing countries. *Ecology of Food and Nutrition* 42:153–76. doi: 10.1080/03670240390198215
- Fanzo, J., Hunter, D., Borelli, T. and Mattei, F.** 2013. Diversifying food and diets: Using agricultural biodiversity to improve nutrition and health. Rome: Bioersivity International. doi: 10.4324/9780203127261
- [FAO] Food and Agriculture Organization.** 2014. Global Blue Growth Initiative and Small Island Developing States. Rome: FAO.
- [FAO] Food and Agriculture Organization.** 2015a. Key recommendations for improving nutrition through agriculture and food system. Rome: FAO.
- [FAO] Food and Agriculture Organization.** 2015b. Compendium of indicators for nutrition-sensitive agriculture. Rome: FAO.
- [FAO] Food and Agriculture Organization.** 2015c. Voluntary guidelines for securing sustainable small-scale fisheries in the context of food security and poverty eradication. Rome: FAO.
- [FAO] Food and Agriculture Organization.** 2015d. Designing nutrition-sensitive agriculture investments. Rome: FAO.
- [FAO] Food and Agriculture Organization.** 2017. Nutrition-sensitive agriculture and food systems in practice: Options for intervention. Rome: FAO.
- [FAO] Food and Agriculture Organization.** 2018. Strengthening sector policies for better food security and nutrition results: Food systems for healthy diets. Rome: FAO.
- [FAO] Food and Agriculture Organization.** 2019. Tonga food security profile. Rome: FAO. [FAO] Food and Agriculture Organization. 2020a. Tuvalu food security profile. Rome: FAO.
- [FAO] Food and Agriculture Organization.** 2020b. Preserve your own food: Promoting healthy eating through home food processing and preservation. Rome: FAO.
- [FAO] Food and Agriculture Organization.** 2021a. New initiative develops tuna products in Pacific Island countries. <http://www.fao.org/in-action/sustainable-nearshore-fisheries-improves-livelihoods-pacific/news/details/en/c/1365506/>
- [FAO] Food and Agriculture Organization.** 2021b. Poverty, malnutrition and food security in Pacific Small Island Developing States. Bangkok: FAO.
- [FAO and SBS] Food and Agriculture Organization; Samoan Bureau of Statistics.** 2020. Food security and food consumption in Samoa. Apia, Samoa: FAO.
- [FAO and SPC] Food and Agriculture Organization; the Pacific Community.** 2012. Priority adaptations to climate change for Pacific fisheries and aquaculture: Reducing risks and capitalizing on opportunities. Noumea, New Caledonia: FAO and SPC.
- [FAO and SPC] Food and Agriculture Organization; the Pacific Community.** 2021. Food consumption in Solomon Islands. Honiara, Solomon Islands: FAO and SPC.
- [FAO, SPREP, SPC, USP] Food and Agriculture Organization; Secretariat of the Regional Environment Program; the Pacific Community; University of the South Pacific.** 2009. Climate change and food security in the Pacific: Policy brief. Rome: FAO.
- [FAO and WHO] Food and Agriculture Organization; World Health Organization.** 2019. Sustainable healthy diets: Guiding principles. Rome: FAO; Geneva: WHO.
- Farmery, A.K., Scott, J.M., Brewer, T.D., Eriksson, H., Steenbergen, D.J., Albert, J., Raubani, J., Tutuo, J., Sharp, M.K. and Andrew, N.L.** 2020. Aquatic foods and nutrition in the pacific. *Nutrients* 12:1–22. doi: 10.3390/nu12123705

- Farrell, P., Thow, A.M., Schuster, S., Vizintin, P. and Negin, J. 2019. Access to a nutritious diet in Samoa: Local insights. *Ecology of Food and Nutrition* 58:189–206. doi: 10.1080/03670244.2019.1582528
- Farrell, P., Thow, A.M., Wate, J.T., Nonga, N., Vatucawaqa, P., Brewer, T., Sharp, M.K., Farmery, A., Trevena, H., Reeve, E. *et al.* 2020. COVID-19 and Pacific food system resilience: Opportunities to build a robust response. *Food Security* 12:783–91. doi: 10.1007/s12571-020-01087-y
- Ferguson, C.E., Tuxson, T., Mangubhai, S., Jupiter, S., Govan, H., Bonito, V., Alefaio, S., Anjiga, M., Booth, J., Boslogo, T. *et al.* 2022. Local practices and production confer resilience to rural Pacific food systems during the COVID-19 pandemic. *Marine Policy* 137:104954.
- Fiorella, K.J., Milner, E.M., Bukusi, E. and Fernald, L.C. 2018. Quantity and species of fish consumed shape breast-milk fatty acid concentrations around Lake Victoria, Kenya. *Public Health and Nutrition* 21:777–84. doi: 10.1017/S1368980017003147
- Friel, S., Schram, A. and Townsend, B. 2020. The nexus between international trade, food systems, malnutrition and climate change. *Nature Food* 1:51–58. doi: 10.1038/s43016-019-0014-0
- Frison, E.A., Cherfas, J. and Hodgkin, T. 2011. Agricultural biodiversity is essential for a sustainable improvement in food and nutrition security. *Sustainability* 3:238–53. doi: 10.3390/su3010238
- [FSANZ] Food Standards Australia New Zealand. 2014. FSANZ advice on fish consumption. Wellington, New Zealand: FSANZ.
- Gillett, R. 2016. Fisheries in the economies of Pacific Island Countries and Territories. Noumea, New Caledonia: SPC.
- Gillett, R. and Tauati, M.I. 2018. Fisheries in the Pacific: Regional and national information. FAO Fisheries and Aquaculture Technical Paper 625. Rome: FAO.
- Global Nutrition Report. 2020. Global nutrition report: Country nutrition profiles.
- Goebel, R., Taylor, M. and Lyons, G. 2014. Feasibility study on increasing the consumption of nutritionally-rich leafy vegetables by indigenous communities in Samoa, Solomon Islands and Northern Australia. Canberra, Australia: Australian Centre for International Agricultural Research.
- Golden, C.D., Gephart, J.A., Eurich, J.G., McCauley, D.J., Sharp, M.K., Andrew, N.L. and Seto, K.L. 2021a. Social-ecological traps link food systems to nutritional outcomes. *Global Food Security* 30:100561. doi: 10.1016/j.gfs.2021.100561
- Golden, C.D., Koehn, J.Z., Shepon, A., Passarelli, S., Free, C.M., Viana, D.F., Matthey, H., Eurich, J.G., Gephart, J.A., Fluet-Chouinard, E. *et al.* 2021b. Aquatic foods to nourish nations. *Nature* 598:315–20. doi: 10.1038/s41586-021-03917-1
- Goris, J.M., Zomerdijk, N. and Temple, V.J. 2017. Nutritional status and dietary diversity of Kamea in Gulf Province, Papua New Guinea. *Asia Pacific Journal of Clinical Nutrition* 26:665–70. doi: 10.6133/apjcn.052016.09
- Hallström, E., Bergman, K., Mifflin, K., Parker, R., Tyedmers, P., Troell, M. and Ziegler, F. 2019. Combined climate and nutritional performance of seafoods. *Journal of Cleaner Production* 230:402–11. doi: 10.1016/j.jclepro.2019.04.229
- Harohau, D., Blythe, J., Sheaves, M. and Diedrich, A. 2020. Uneven adoption of tilapia aquaculture in rural Solomon Islands. *Aquaculture International* 28:2093–2109. doi: 10.1007/s10499-020-00577-2
- Hau'ofa, E. 2008. *We Are the Ocean*. Honolulu, US: University of Hawaii Press. doi: 10.1515/9780824865542
- Headey, D., Hirvonen, K. and Hoddinott, J. 2018. Animal sourced foods and child stunting. *American Journal of Agricultural Economics* 100:1302–19. doi: 10.1093/ajae/aay053
- Hibbeln, C.J.R., Spiller, P., Brenna, J.T., Golding, J., Holub, B.J., Harris, W.S., Kris-Etherton, P., Lands, B., Connor, S.L., Myers, G. *et al.* 2019. Relationships between seafood consumption during pregnancy and childhood and neurocognitive development: Two systematic reviews. *Prostaglandins, Leukotrienes & Essential Fatty Acids* 151:14–36. doi: 10.1016/j.plefa.2019.10.002
- Hicks, C.C., Cohen, P.J., Graham, N.A.J., Nash, K.L., Allison, E.H., D'Lima, C., Mills, D.J., Roscher, M., Thilsted, S.H., Thorne-Lyman, A.L. and MacNeil, M.A. 2019. Harnessing global fisheries to tackle micronutrient deficiencies. *Nature* 574:95–98. doi: 10.1038/s41586-019-1592-6



- [HLPE] High Level Panel of Experts.** 2014. Sustainable fisheries and aquaculture for food security and nutrition. A report by the High-Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Rome: FAO.
- [HLPE] High Level Panel of Experts.** 2020. Food security and nutrition: Building a global narrative towards 2030. Rome: HLPE.
- Horsey, B., Swanepoel, L., Underhill, S., Aliakbari, J. and Burkhart, S.** 2019. Dietary diversity of an adult Solomon Islands population. *Nutrients* 11:1–14. doi: 10.3390/nu11071622
- Hughes, R. and Lawrence, M.** 2005. Globalisation, food and health in Pacific Island countries. *Asia Pacific Journal of Clinical Nutrition* 14(4):298–306.
- Hughes, R.G. and Marks, G.C.** 2009. Against the tide of change: Diet and health in the Pacific Islands. *Journal of the American Dietetic Association* 109:1700–03. doi: 10.1016/j.jada.2009.07.015
- [IFC] International Finance Corporation.** 2016. Case study: SolTuna – Tuna processing, Solomon Islands. Washington DC: IFC.
- Imhoff-Kunsch, B., Briggs, V., Goldenberg, T. and Ramakrishnan, U.** 2012. Effect of n-3 long-chain polyunsaturated fatty acid intake during pregnancy on maternal, infant, and child health outcomes: A systematic review. *Paediatric and Perinatal Epidemiology* 26:91–107. doi: 10.1111/j.1365-3016.2012.01292.x
- Jones, A.D.** 2017. Critical review of the emerging research evidence on agricultural biodiversity, diet diversity, and nutritional status in low- and middle-income countries. *Nutrition Reviews* 75:769–82. doi: 10.1093/nutrit/nux040
- Jones, H.A. and Charlton, K.E.** 2015. A cross-sectional analysis of the cost and affordability of achieving recommended intakes of non-starchy fruits and vegetables in the capital of Vanuatu. *BMC Public Health* 15:1–10. doi: 10.1186/s12889-015-1644-2
- Kawarazuka, N. and Béné, C.** 2011. The potential role of small fish species in improving micronutrient deficiencies in developing countries: Building evidence. *Public Health Nutrition* 14:1927–38. doi: 10.1017/S1368980011000814
- [KNSO, FAO, SPC]. Kiribati National Statistics Office; Food and Agriculture Organization; Pacific Community.** 2021. Kiribati food security profile.
- Kuipers, R.S., Fokkema, M.R., Smit, E.N., van der Meulen, J., Boersma, E.R. and Muskiet, F.A.J.** 2005. High contents of both docosahexaenoic and arachidonic acids in milk of women consuming fish from lake Kitangiri (Tanzania): Targets for infant formulae close to our ancient diet? *Prostaglandins, Leukotrienes & Essential Fatty Acids* 72:279–88. doi: 10.1016/j.plefa.2004.12.001
- Lau, J., Sutcliffe, S. and Hungito, W.** 2020. Lived experiences of Covid-19: Impacts on an atoll island community, Papua New Guinea. Townsville, Australia: James Cook University.
- Lawless, S., Cohen, P., McDougall, C., Orirana, G., Siota, F. and Doyle, K.** 2019. Gender norms and relations: Implications for agency in coastal livelihoods. *Maritime Studies* 1–12. doi: 10.1007/s40152-019-00147
- Leroy, J.L., Frongillo, E.A., Dewan, P., Black, M.M. and Waterland, R.A.** 2020. Can children catch up from the consequences of undernourishment? Evidence from child linear growth, developmental epigenetics, and brain and neurocognitive development *Advances in Nutrition* 11:1032–41. doi: 10.1093/ADVANCES/NMAA020
- López-Angarita, J., Hunnam, K.J., Pereira, M., Mills, D.J., Pant, J., Teoh, S.J., Eriksson, H., Amaral, L. and Tilley, A.** 2019. Fisheries and aquaculture of Timor-Leste in 2019: Current knowledge and opportunities. Penang, Malaysia: WorldFish.
- Love, D.C., Allison, E.H., Asche, F., Belton, B., Cottrell, R.S., Froehlich, H.E., Gephart, J.A., Hicks, C.C., Little, D.C., Nussbaumer, E.M. et al.** 2021. Emerging COVID-19 impacts, responses, and lessons for building resilience in the seafood system. *Global Food Security* 28:100494. doi: 10.1016/j.gfs.2021.100494
- Mahmudiono, T., Segalita, C. and Rosenkranz, R.R.** 2019. Socio-ecological model of correlates of double burden of malnutrition in developing countries: A narrative review. *International Journal of Environmental Research and Public Health* 16. doi: 10.3390/ijerph16193730

- Mangubhai, S. and Lawless, S.** 2021. Exploring gender inclusion in small-scale fisheries management and development in Melanesia. *Marine Policy* 123:104287. doi: 10.1016/j.marpol.2020.104287
- Marinda, P.A., Genschick, S., Khayeka-Wandabwa, C., Kiwanuka-Lubinda, R. and Thilsted, S.H.** 2018. Dietary diversity determinants and contribution of fish to maternal and under five nutritional status in Zambia. *PLOS ONE* 13:1–18. doi: 10.1371/journal.pone.0204009
- Martin, M.A., Lassek, W.D., Gaulin, S.J.C., Evans, R.W., Woo, J.G., Geraghty, S.R., Davidson, B.S., Morrow, A.L., Kaplan, H.S. and Gurven, M.D.** 2012. Fatty acid composition in the mature milk of Bolivian forager-horticulturalists: Controlled comparisons with a US sample. *Maternal and Child Nutrition* 8:404–18. doi: 10.1111/j.1740-8709.2012.00412.
- McCorrison, S., Hemming, D.J., Lamontagne-Godwin, J.D., Osborn, J., Parr, M.J. and Roberts, P.D.** 2013. What is the evidence of the impact of agricultural trade liberalisation on food security in developing countries? A systematic review. London: EPPI-Centre, Social Science Research Unit, Institute of Education, University of London.
- McIver, L., Kim, R., Woodward, A., Hales, S., Spickett, J., Katscherian, D., Hashizume, M., Honda, Y., Kim, H., Iddings, S., Naicker, J. et al.** 2016. Health impacts of climate change in Pacific island countries: A regional assessment of vulnerabilities and adaptation priorities. *Environmental Health Perspectives* 124:1707–14. doi: 10.1289/ehp.1509756
- Michaelsen, K.F., Hoppe, C., Roos, N., Kaestel, P., Stougaard, M., Lauritzen, L., Mølgaard, C., Girma, T. and Friis, H.** 2009. Choice of foods and ingredients for moderately malnourished children 6 months to 5 years of age. *Food and Nutrition Bulletin* 30.
- Morgan, E.H., Vatucawaqa, P., Snowdon, W., Worsley, A., Dangour, A.D. and Lock, K.** 2016. Factors influencing fruit and vegetable intake among urban Fijians: A qualitative study. *Appetite* 101 114–18. doi: 10.1016/j.appet.2016.03.003
- Mozaffarian, D. and Rimm, E.B.** 2006. Fish intake, contaminants, and human health. *JAMA* 296:1885. doi: 10.1001/jama.296.15.1885
- Murphy, S.P. and Allen, L.H.** 2003. Nutritional importance of animal source foods. *Journal of Nutrition* 133:3932S–5S. doi: 10.1093/jn/133.11.3932S
- Nash, K.L., MacNeil, M.A., Blanchard, J.L., Cohen, P.J., Farmery, A.K., Graham, N.A.J., Thorne-Lyman, A.L., Watson, R.A. and Hicks, C.C.** 2022. Trade and foreign fishing mediate global marine nutrient supply. *Proceedings of the National Academy of Sciences* 119(22).
- O’Meara, L., Williams, S., Mooney, J., Hickes, D. and Brown, P.** Forthcoming. Food security of indigenous food-producing households: Gendered perspectives from rural Fiji.
- O’Meara, L., Williams, S.L., Hickes, D. and Brown, P.** 2019. Predictors of dietary diversity of indigenous food-producing households in rural Fiji. *Nutrients* 11:1–16. doi: 10.3390/nu11071629
- [PIFR] Pacific Island Food Revolution.** n.d. Recipes. Accessed September 24, 2021. <https://www.pacificislandfood-revolution.com/recipes/>
- Popkin, B.M., Corvalan, C. and Grummer-Strawn, L.M.** 2020. Dynamics of the double burden of malnutrition and the changing nutrition reality. *Lancet* 395:65–74. doi: 10.1016/S0140-6736(19)32497-3
- Roeger, J., Foale, S. and Sheaves, M.** 2016. When “fishing down the food chain” results in improved food security: Evidence from a small pelagic fishery in Solomon Islands. *Fisheries Research*. doi: [10.1016/j.fishres.2015.10.016](https://doi.org/10.1016/j.fishres.2015.10.016)
- Ruel, M.T., Quisumbing, A.R. and Balagamwala, M.** 2018. Nutrition-sensitive agriculture: What have we learned so far? *Global Food Security* 17:128–53. doi: 10.1016/j.gfs.2018.01.002
- Sandström, B., Almgren, A., Kivistö, B. and Cederblad, Å.** 1989. Effect of protein level and protein source on zinc absorption in humans. *Journal of Nutrition* 119:48–53. doi: 10.1093/jn/119.1.48
- Santos, J.A., Mckenzie, B., Trieu, K., Farnbach, S., Johnson, C., Schultz, J., Thow, A.M., Snowdon, W., Bell, C. and Webster, J.** 2019. Contribution of fat, sugar and salt to diets in the Pacific Islands: A systematic review. *Public Health and Nutrition* 22:1858–71. doi: 10.1017/S1368980018003609

- Sharp, M.** 2011. The benefits of fish aggregating devices in the Pacific. *SPC Fish Newsl.* Noumea, New Caledonia: SPC.
- Sherzad, S.** 2020. Impacts of COVID-19 on the food systems in the Pacific small island developing states (PSIDS) and a look into the PSIDS responses. Rome: FAO. 1–15.
- Sievert, K., Lawrence, M., Naika, A. and Baker, P.** 2019. Processed foods and nutrition transition in the Pacific: Regional trends, patterns and food system drivers. *Nutrients* 11:1328. doi 10.3390/nu11061328.
- Snowdon, W. and Thow, A.M.** 2013. Trade policy and obesity prevention: Challenges and innovation in the Pacific Islands. *Obesity Reviews* 14:150–58. doi: 10.1111/obr.12090
- [SPC] Pacific Community.** 2015. A new song for coastal fisheries: Pathways to change. Noumea, New Caledonia: SPC.
- [SPC] Pacific Community.** 2018. Pacific guidelines for healthy living: A handbook for health professionals and educators. Noumea, New Caledonia: SPC.
- [SPC] Pacific Community.** 2019. Policy brief No 32: Implications of climate-driven redistribution of tuna for Pacific Island economies. Noumea, New Caledonia: SPC.
- [SPC] Pacific Community.** 2021. 13th SPC Heads of Fisheries Meeting: Synthesis of COVID-19 impacts on fisheries and aquaculture in the Pacific Information Paper 5. Noumea, New Caledonia: SPC.
- [SPC, UOW, FAO] Pacific Community; University of Wollongong; Food and Agriculture Organization.** 2020. The Pacific nutrient database user guide: A tool to facilitate the analysis of poverty, nutrition and food security in the Pacific region. Noumea, New Caledonia: SPC.
- Strain, J.J., Yeates, A.J., Van Wijngaarden, E., Thurston, S.W., Mulhern, M.S., McSorley, E.M., Watson, G.E., Love, T.M., Smith, T.H. and Yost, K.** 2015. Prenatal exposure to methyl mercury from fish consumption and polyunsaturated fatty acids: Associations with child development at 20 mo of age in an observational study in the Republic of Seychelles. *American Journal of Clinical Nutrition* 101:530–37. doi: 10.3945/ajcn.114.100503
- Sutcliffe, S., Lau, J., Barnes, M., Mbaru, E., Wade, E., Muthiga, N., Hungito, W., Muly, I., Wanyonyi, S. and Cinner, J.** In review. COVID-19 policy impact pathways and feedbacks: A food systems analysis in small-scale fishing communities.
- Swanepoel, L., Tioti, T., Eria, T., Tamuera, K., Tiitii, U., Larson, S. and Paul, N.** 2020. Supporting women’s participation in developing a seaweed supply chain in Kiribati for health and nutrition. *Foods* 9. doi: 10.3390/foods9040382
- Teng, A., Snowdon, W., Win Tin, S.T., Genç, M., Na’ati, E., Puloka, V., Signal, L. and Wilson, N.** 2021. Progress in the Pacific on sugar-sweetened beverage taxes: A systematic review of policy changes from 2000 to 2019. *Australian and New Zealand Journal of Public Health* 45(4):376–84. doi: 10.1111/1753-6405.13123.
- Thilstead, S.H., Thorne-Lyman, A., Webb, P., Bogard, J.R., Subasinghe, R., Phillips, M.J. and Allison, E.H.** 2016. Sustaining healthy diets: The role of capture fisheries and aquaculture for improving nutrition in the post-2015 era. *Food Policy* 61:126–31.
- Thow, A.M., Heywood, P., Schultz, J., Quested, C., Jan, S. and Colagiuri, S.** 2011. Trade and the nutrition transition: Strengthening policy for health in the Pacific. *Ecology of Food and Nutrition* 50:18–42. doi: 10.1080/03670244.2010.524104
- Thow, A.M., Annan, R., Mensah, L. and Chowdhury, S.N.** 2014. Development, implementation and outcome of standards to restrict fatty meat in the food supply and prevent NCDs: Learning from an innovative trade/ food policy in Ghana. *BMC Public Health* 14:1–9. doi: 10.1186/1471-2458-14-249
- Tilley, A., Hunnam, K.J., Mills, D.J., Steenbergen, D.J., Govan, H., Alonso-Poblacion, E., Roscher, M., Pereira, M., Rodrigues, P., Amazdor, T. et al.** 2019a. Evaluating the fit of co-management for small-scale fisheries governance in Timor-Leste. *Frontiers in Marine Science* 6.
- Tilley, A., Wilkinson, S.P., Kolding, J., López-Angarita, J., Pereira, M. and Mills, D.J.** 2019b. Nearshore fish aggregating devices show positive outcomes for sustainable fisheries development in Timor-Leste. *Frontiers in Marine Science* 6.
- Tilley, A., Burgos, A., Duarte, A., Dos Reis Lopes, J., Eriksson, H. and Mills, D.** 2021. Contribution of women’s fisheries substantial, but overlooked, in Timor-Leste. *Ambio* 50:113–24.
- Tilley, A., Byrd, K.A., Pincus, L., Klumpyan, K., Dobson, K., do Reis Lopes, J. and Shikuku, K.M.** 2021. A randomised controlled trial to test the effects of fish aggregating devices and SBC activities promoting fish consumption in Timor-Leste: A study protocol. medRxiv.

- Troell, M., Naylor, R.L., Metian, M., Beveridge, M., Tyedmers, P.H., Folke, C., Arrow, K.J., Barrett, S., Crépin, A.S., Ehrlich, P.R. et al.** 2014. Does aquaculture add resilience to the global food system? *Proceedings of the National Academy of Sciences of the United States of America* 111:13257–63. doi: 10.1073/pnas.1404067111
- [UN] United Nations.** 2014. Third International Conference on Small Island Developing States the outcome of which was the SIDS Accelerated Modalities of Action Pathway, commonly known as the SAMOA Pathway. Apia, Samoa. September 1–4, 2014.
- [UN] United Nations.** 2015. Transforming our world: The 2030 Agenda for Sustainable Development. New York: UN.
- [UN] United Nations.** n.d. The UN Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing States. New York, UN: Accessed September 24, 2021. <https://www.un.org/ohrlls/>
- Underhill, S.J.R., Zhou, Y., Sherzad, S., Singh-Peterson, L. and Tagoai, S.M.** 2017. Horticultural postharvest loss in municipal fruit and vegetable markets in Samoa. *Food Security* 9:1373–83. doi: 10.1007/s12571-017-0734-7
- [UNICEF] United Nations Children’s Fund.** 2010. Food and nutrition security in Pacific island nations and territories: A position paper with emphasis on food and nutrition security of mothers and children. Suva, Fiji: UN.
- [USAID] United States Agency for International Development.** 2016. Monitoring report – Solomon Islands – SolTuna Processing Facility. Honiara, Solomon Islands: USAID.
- Vermeulen, S., Park, T., Khoury, C., Mockshell, J., Béné, C., Thi, H., Heard, B. and Wilson, B.** 2019. Changing diets and transforming food systems. CCAFS Working Paper no. 282. Wageningen, The Netherlands: CGIAR.
- Victora, C.G., Adair, L., Fall, C., Hallal, P.C., Martorell, R., Richter, L., Sachdev, H.S. and the Maternal and Child Undernutrition Study Group.** 2008. Maternal and child undernutrition: Consequences for adult health and human capital. *Lancet* 371:340–57. doi: 10.1016/S0140-6736(07)61692-4
- Victora, C.G., Christian, P., Vdaletti, L.P., Gatica-Domínguez, G., Menon, P. and Black, R.E.** 2021. Revisiting maternal and child undernutrition in low-income and middle-income countries: Variable progress towards an unfinished agenda. *Lancet* 6736. doi: 10.1016/S0140-6736(21)00394-9
- [WFP] World Food Programme.** 2016. Tropical Cyclone Winston food security and livelihoods recovery needs assessment. Suva, Fiji: WFP.
- [WFP and SPC] World Food Programme; the Pacific Community.** 2018. Food security in vulnerable islands: A regional food security atlas of the Pacific. New Caledonia.
- [WHO] World Health Organization.** 2017a. Report on fiscal policies to reduce consumption of sugar- sweetened beverages and other regulatory measures to promote healthy diets in the Republic of Maldives. Geneva: WHO.
- [WHO] World Health Organization.** 2017b. Tackling NCDs “best buys” and other recommended interventions for the prevention and control of noncommunicable diseases. Geneva: WHO.
- Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A. et al.** 2019. Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *Lancet* 393:447–92. doi: 10.1016/S0140-6736(18)31788-4
- Yakes, J., Mangani, C., Ashorn, P., Harris, W.S., Maleta, K. and Dewey, K.G.** 2015. Breast milk from women living near Lake Malawi is high in docosahexaenoic acid and arachidonic acid. *Prostaglandins, Leukotrienes & Essential Fatty Acids* 95:71–78. doi: 10.1016/j.plefa.2014.12.002



# Contacts

Subregional Office for the Pacific Islands  
**Food and Agriculture Organization of the United Nations**



SIDS Street, Tuana'ímato, Apia,  
Samoa



Tel: +685 22127  
Fax: +685 22126



SAP-SRC@fao.org  
fao.org/asiapacific/our-offices/pacific-islands



@FAOPacific



@FAOPacific

In collaboration with:

