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RESEARCH ARTICLE

Food security and small holder farming in Pacific Island countries and territories: A scoping review

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Abstract

UN Sustainable Development Goal (SDG) 2: Zero Hunger links ending hunger to achieving food security, improving nutrition, and promoting sustainable agriculture. The Pacific Island Countries and Territories (PICTs) is a region where such linkages can be investigated as the PICTs are confronting climate change while facing a decrease in available arable land and increasing rates of urbanisation. Around 80% of all Pacific Islanders still rely on agricultural produce from their own gardens or from small holder farmers to support or to supplement their diets. The Food and Agriculture Organisation (FAO) has declared the years 2019–2028 to be the Decade of Family Farming. Food imports are increasingly common in PICTs, and can provide cheap, although not particularly nutritious foods, leading to generalised health problems. Increased reliance on imports is itself an indicator of diminishing food security, and with the PICTs facing a range of food security challenges, it is timely to assess the existing literature in the PICTs on the relationship between smallholder farming and food security. This scoping review analyses 49 peer reviewed and grey literature studies in English from 1970–2019 concerning the relationship between food security and small holder farming in the PICTs. It identifies four main themes: (1) Community adaptation, resilience and crop diversification; (2) Decreased availability of local foods and land; (3) Changes in diet; (4) Gender and agricultural production. The review shows Pacific peoples quickly adapt to changing circumstances to plant different crops both for food and for sale, and it identifies the role of small holder agriculture as crucial to: (1) growing local foods to support food security, and (2) expanding domestic asset creation to promote economic development, especially for women.

Author summary

Around 80% of Pacific Islanders are primarily subsistence or semi-subsistence producers, meeting most of their daily food needs with produce from their village food gardens. Most land in the Pacific Islands Countries and Territories (PICTs) is also held by customary

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title, and is farmed either by individuals or by families, and this is unlikely to change due to the reluctance of Pacific Islands governments to alter customary land title. In this scoping review we explore the articulation of small-scale family farming with food security in the PICTs. We have undertaken this study as the FAO has called for climate change and food security policies to be aligned more closely, and because it sees family farming as contributing to the achievement of all the SDGs. As the localisation of the SDGs is dependent on local context, we argue that in the Pacific region this relationship warrants close attention due to increasingly erratic weather patterns caused by climate change, as well as increasing population, urbanisation, and a decrease in arable land.

Introduction

The Pacific Islands Countries and Territories (PICTs), a grouping of 22 independent states, dependent territories, and states in free association with other states, share some similarities with other parts of the Global South. They have generally low levels of development, aid dependency, and an increasing share of imported foods in people's diets. The PICTs also have specific localised issues to address when achieving food security, one of which is scale. With the exception of the largest PICT in both population and area—Papua New Guinea (PNG), which has 8.4 million people and 452,000 km^2—the PICTs have populations of under one million, ranging from the second most populous PICT, Fiji (896,000), to Niue (1,626) and Tokelau (1,357), while 14 of the PICTs have land areas of less than 1000 km^2 [1]. Achieving UN Sustainable Development Goal (SDG) 2: Zero Hunger presents enormous challenges for states and societies everywhere, however they are acute for the 11.7 million people of the PICTs. Small economies and comparatively vast distances between PICTs result in high transport and labour costs that discourages inter-island trade. While around 80% of Pacific Islanders are primarily subsistence or semi-subsistence producers, PICT populations also have little ready cash and limited incomes [2] which makes food purchase difficult, and domestic markets fragile.

In 2012, a United Nations assessment of progress towards the Millennium Development Goals noted with respect to MDG 1: Eradicate Extreme Poverty and Hunger in 'Oceania'—a term used to describe the area and peoples of the Pacific and which can include Australia and New Zealand [3]—was experiencing 'moderate hunger', 'very high poverty', and that it had a very large 'deficit in decent work' [4]. Since the 1980s aid donors to PICTs have encouraged international trade and increased integration in global commodity chains which has led to the development of niche export agricultural products such as squash in Tonga (which collapsed in the late 1990s [5]), as well as taro in Niue [6] or cocoa in Solomon Islands [7]. At the same time international development agencies such as UN Women have focussed on women's participation in the development and promotion of domestic agriculture markets in Fiji, Vanuatu and Solomon Islands through its Markets for Change Program (2014–2019) [8].

UN Sustainable Development Goal (SDG) 2 *Zero Hunger*: *End Hunger*, *achieve food security and improved nutrition and promote sustainable agriculture* "recognizes the inter linkages among supporting sustainable agriculture, empowering small farmers, promoting gender equality, ending rural poverty, ensuring healthy lifestyles, tackling climate change. . ." [9]. These are significant challenges for all states, but they are particularly challenging for PICTs where unlike in many parts of Africa, there has been no "agricultural transformation" [10]), and little linking of small holder farming with a global market. The future needs of PICTs in terms of their food security is of central concerns to PICTs and aid donors due to climate change, increasing populations, urbanisation and decreasing level of available arable land.

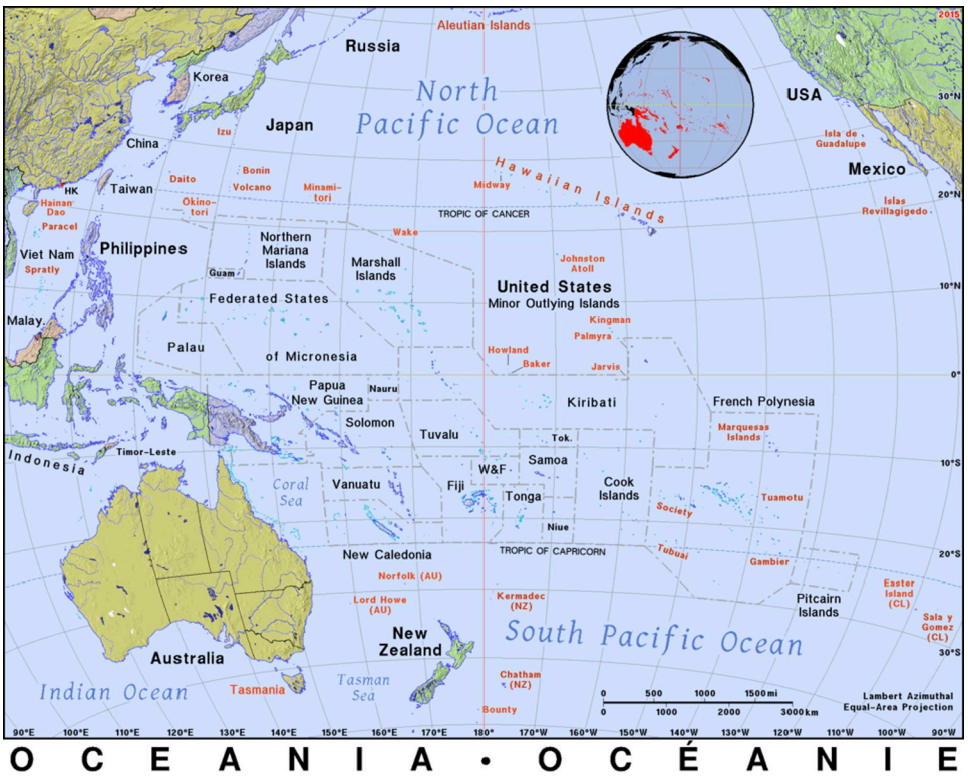

Fig 1. Oceania. Source: https://ian.macky.net/pat/map/ocea/ocea.html.

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In the PICTs family farming is small holder farming, however the physical geography of many PICTs (See Fig 1) makes family farms especially susceptible to climate change and variable weather patterns. Fiji has already been forced to relocate communities due to sea level rise and coastal erosion [11]. The vulnerability of small island states to climate change is also clear—if PNG is removed from the PICTs, 90% of the remaining PICT population live within 10km of the ocean [12]; PICTs are thus highly vulnerable to climate related natural disasters, as well as increasing soil salinity through rising sea levels.

As can be seen, the Pacific region is more aptly a 'Sea of Islands' [13] as its ratio of land to water is less than half of one percent [14]. All of the PICTs are located in 'Oceania' (a concept invented by Danish radical journalist and geographer Conrad Malte-Brun in 1812), however in 1832 the French explorer Jules Dumont d'Urville's created three subregional groupings for Oceania: Melanesia ('black islands'), Polynesia ('many islands') and Micronesia ('small islands') [15] (See Fig 2). While initially these sub-categories meant little to Pacific Islanders, today they form the basis of very real cultural, social and political identities [16].

In both land area and population, Melanesia dominates the PICTs: the Melanesian population—PNG (8,418,346), Fiji (912,241), Solomon Islands (623,000), Vanuatu (282,117), and the French special collectivity of New Caledonia (279,821)—together comprises 89.5% of the total PICT population of 11,739,367 [1]. The Pacific Community suggests this overall figure will increase to 14.5 million by 2030, and to 19.5 million by 2050, by which time PNG's population would be over 15 million [17].

Melanesian dominance in land area sees PNG account for 85% of the total PICT land area (551,000 km^2), while the smallest Melanesian state of Vanuatu (12,281 km^2) is still larger than the combined land area of all of Polynesia (8,126 km^2) and Micronesia (3,156 km^2) [17].

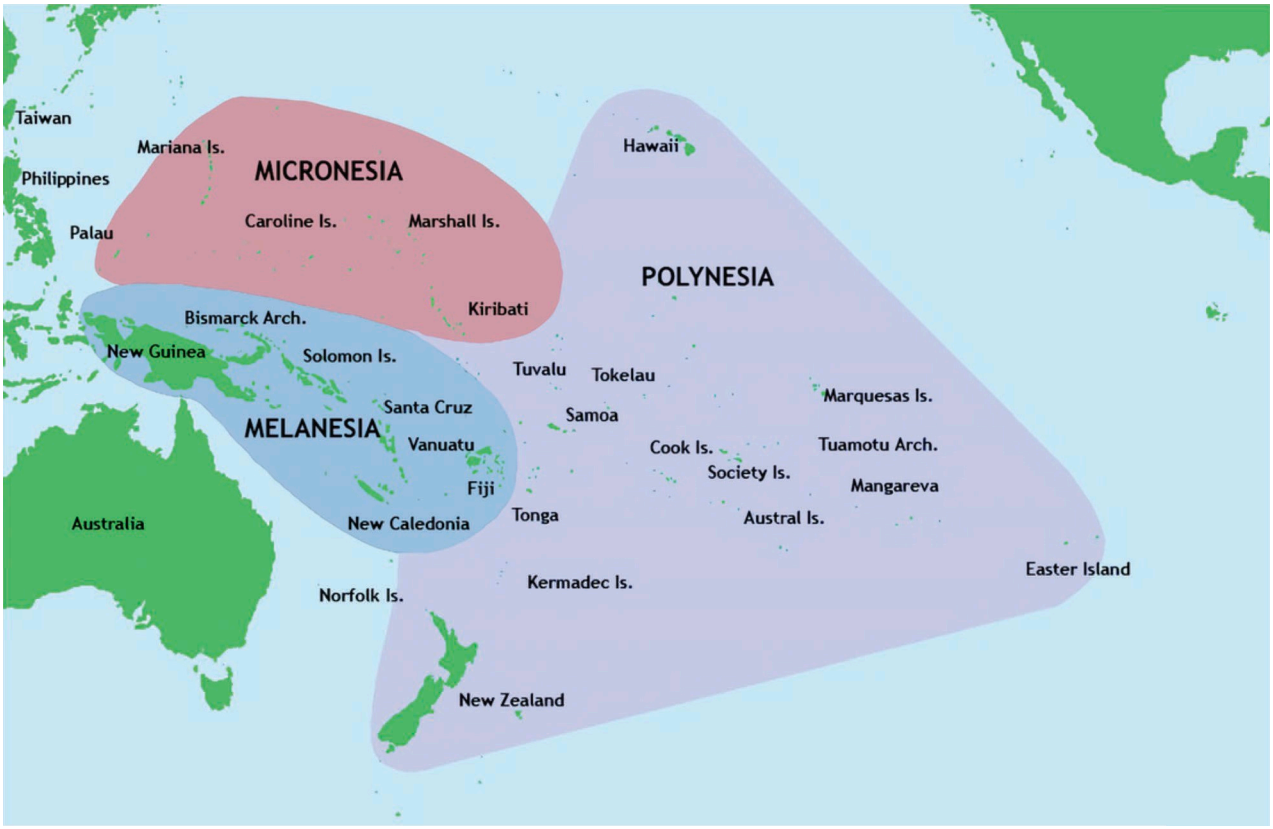

Fig 2. Pacific Culture Areas. https://en.wikipedia.org/wiki/File:Pacific_Culture_Areas.png.

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The economic development of the PICTs has been influenced by colonialism, relatively late and ongoing decolonisation, and late integration into the global economy. The oldest independent state in the Pacific is Samoa (1962), and while most PICTs were independent by the end of the 1980s, decolonisation in the Pacific remains an on-going process [18]. The larger Melanesian PICTs contain some plantation agriculture, and usually resource extraction (logging, mining, fishing), but most smaller PICTs are services based and reliant on tourism, or on government employment. Formal employment is very limited. Most people are engaged in the agricultural sector, a fact that proved beneficial during the COVID-19 induced economic downturn of early 2020 as the PICTs remained self-sufficient in agriculture [19].

One obvious challenge to future food security is urbanisation, as people moving to towns and cities do not have sufficient space to grow food to feed themselves. Urban residents must rely on others to provide food—gifts from relatives still living on the land, fresh food sold at markets, or imported food from shops/trade stores or supermarkets. The demographic dominance of the Melanesian states and their mostly rural settlement patterns make the PICTs on average mostly rural (77% rural in mid-2018), however this belies the heavy localised urbanisation in both Micronesia (75.5%), and Polynesia (49.3%). For Micronesia, almost 95% of Guam's 165,718 people live in urban environments, while for the Commonwealth of Northern Mariana Islands (CNMI) (population 57,194), the urbanisation rate is 91.6%. In Polynesia, Cook Islands (17,411) is 75.1% urbanised, and 61.8% of people in French Polynesia (population 285,859) live in urban centres. Samoa (18% of 197,695) and Tonga (23.1% of 109,198) both go against the general Polynesian urbanisation trend, recording much lower levels. This is similar to Melanesia where urbanisation is just 19.4%, however this figure is also deceptive.

In New Caledonia 70.7% of its 279,821 people are urban dwellers, as are 56.2% of Fiji's population of 912,241, but the rural population is dominant in PNG where just 13.2% of its 8.4 million people live in towns or cities, as it is in Solomon Islands (23.7% of 623,281 people in towns and cities), and Vanuatu (25.3% of 307,000 people) [1].

Given 2019–2028 is the FAO's Decade of Family Farming [20], it is timely to assess the relationship between smallholder farming and food security in the PICTs through a scoping review of previous literature. This exercise is undertaken to identify key themes in food security research and to provide recommendations that may improve food security in the PICTs. This article first outlines the method used in this scoping review of food security and small holder farming. It then discusses the literature, which is grouped under the four themes: community adaptation, resilience, and crop diversification; decreased availability of local foods and land; changes in diet; gender and agricultural production. Finally, a discussion of these main themes highlights salient points and their implications. The importance of domestic food production to food security in PICTs has flow-on effects to the financial empowerment of women. We argue that in some of the larger PICTs there is scope for greater donor assistance to promote small farming, and to link this better to domestic markets to enhance food security and sustainable economic growth. Such an approach may reduce food imports in Melanesia and parts of Polynesia, however it would not be possible in small and highly urbanised PICTs where people are more dependent on imported food.

Material and methods

This scoping review is guided by the following question: "What is the relationship of small holder agricultural production to food security in Pacific Island Countries and Territories?" While this should be a relatively simple question, it is complicated by the fact that globally there is no clear and accepted definition of small holder farming. Rapsomanikis [21] notes, "Often scale, measured in terms of the farm size, is used to classify farmers into small and large", so while across the world farm size varies, as does what is being produced, it is also the case that "[a]verage small farm sizes hide significant productivity differences across countries", a factor that creates "differences due to soil quality, technology and productive assets, such as irrigation". In 1979 Yen classified the Pacific Islands' primary production systems into three types: "integral subsistence systems; mixed subsistence-cash cropping systems; and the 'plantation' mode" [22]. In this review we adapt this typology to conceptualise small holder agriculture as family and/or community farming of fresh, locally produced food that is either "integral subsistence systems" or "mixed subsistence cash cropping", and we do not consider the plantation mode of farming as small holder agriculture. We rule out plantations as: (1) the capital required for such ventures is normally exogenous; (2) the commodity is grown at an economy of scale well beyond that of small farmers; (3) the quantity of land required exceeds individual or community land; (4) the commodity grown is generally a single exportable product (e.g. coffee, copra, sugar, tea), and: (5) the intended end market and consumer are outside of the PICTs. We acknowledge that some people in PICTs gain labour from employment on plantations and use the cash gained to purchase food, however we do not regard them as engaged in agricultural production for food security in the same way as a person who grows produce on their own land for market sale.

Search strategy

This scoping review is informed by the standard Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols (PRISMA-P) reporting guidelines [23]. A list of relevant text words or corresponding controlled vocabulary according to each database was used to

comprehensively search nine computerized bibliographic databases for studies published between January 1970 and December 2019 (just before the onset of the global COVID-19 pandemic). The databases searched were: Academic Search Complete, AGRICOLE, Food Science and Technology abstracts, JSTOR, ProQuest Agricultural and Environmental Science Collection, ProQuest Biological Science, ProQuest Dissertation and Thesis A&I, Scopus and Science direct. Additionally, grey literature documents—studies produced by organisations for whom publication is not their principal endeavour but which includes reports often written by contracted or other academics, and usually to a very high research standard—were searched from the websites of the International Organisations, funding organisations and government departments listed below:

- Asian Development Bank (ADB)
- Australian Agency for International Development (AusAID)
- Australian Government–Department of Foreign Affairs and Trade (DFAT)
- Development of Sustainable Agriculture in the Pacific (DSAP)
- European Union Funding Agency (ER)/ European Commission (EC)
- Food and Agriculture Organization (FAO)
- Office of the High Commissioner for Human Rights (OHCHR)
- Secretariat of the Pacific Community (SPC)
- Secretariat of the Pacific Regional Environmental Programme (SPREP)
- United Nations (UN) Women
- UN Economic and Social Commission for Asia and the Pacific (ESCAP)
- UN Children's Emergency Fund (UNICEF) (East Asia and Pacific Region)
- UN Development Programme (UNDP)
- United Nations in the Pacific
- United States of America Department of Agriculture (USDA) Western Region Sustainable Agriculture Research and Education (SARE) in the Pacific
- World Health Organization (WHO)
- World Vision

The following combination of subject headings and keywords were used:

"Pacific Island*" OR "Kiribati" OR "Tuvalu" OR "Micronesia" OR "Papua New Guinea" OR "Nauru" OR "Palau" OR "Solomon Island*" OR "Marshall Island*" OR "Samoa" OR "American Samoa" OR "Cook Island*" OR "Fiji" OR "New Caledonia" OR "Tokelau" OR "French Polynesia" OR "Niue" OR "Tonga" OR "Guam" OR "Vanuatu" OR "Pitcairn Island" OR "Wallis and Futuna" OR "Northern Mariana Island*" OR "Federated States of Micronesia" OR "Polynesia" OR "Melanesia"

AND

"food secur*" OR "food insecurit*" OR "food suppl*" OR "food inequalit*" OR "food market*" OR "food availability*" OR "food access*" OR "food utilisation" OR "food utilization" OR "asset creation"

AND

"small holder agriculture" OR "agriculture*" OR "fresh food" OR "farm produc*" OR "fresh produc*" OR "leafy green*" OR "vegetable*" OR "legume*" OR "bean*" OR "gourd*" OR "nut*" OR "local" OR "farm*" OR "local farmer*" OR "farmer market*" OR "community supported agriculture" OR "sustainable agriculture" OR "fruit*".

Inclusion and exclusion criteria

This scoping review includes peer reviewed articles and other scholarly studies such as reports, working papers, and dissertations, both published and unpublished [24–25]. Books, news articles and editorial opinion pieces have not been included. Grey literature sources included were based on the most frequently cited content in reviews [26], and mainly included Project Reports, Evaluation Reports, and other relevant documents. Study types included are mixed methods, qualitative and/or quantitative. The base year is taken as 1970, as around this time the consumption patterns of Pacific communities began to shift to include imported foods, there was an increased shift toward farming produce for the local market, and the population of the region began to increase [27–28].

Limitations. Only studies in English language were considered for this review. As the focus is on small holder farmers and food security, this review only considers the literature on agricultural food sources such as vegetables (which includes root crops) and fruits. It excludes fish (covered by Charlton et al. [27]), aquatic foods and livestock.

Study selection process

Studies yielded in the literature search were imported into EndNote software. A three-staged screening approach was used to examine the eligibility of studies for inclusion. Firstly, studies were screened to eliminate any duplicates. Second, manual screening of titles removed any obviously irrelevant studies. Lastly, abstracts of the remaining studies were manually screened to confirm eligibility and relevance. The study selection process is summarised in Fig 3 below.

For refereed journal articles, a total of 4,430 articles were retrieved from the nine databases. From this, 464 duplicated items were removed leaving 3,966 articles for a screening of titles. Following removal of less relevant titles, 72 articles remained. These were read again and a further 36 articles were excluded. The full texts of the remaining 36 articles were then reviewed. From other refereed academic literature, 11 full text studies not publicly available through databases were identified and were obtained by contacting the authors. When added to the 36 articles, this yielded a total of 47 studies to be reviewed for full text eligibility. Eighteen articles that were outside the scope of the study were then excluded, leaving a total of 29 peer reviewed studies for review.

For grey literature, the search process included screening the websites of various organisations over the first 20 pages of google and google scholar results, a process that resulted in 114 reports being identified for consideration. Full text screening of these led to the exclusion of 84 reports, leaving 30 reports. A review of the remaining reports led to the exclusion of a further 10 reports, leaving 20 studies from grey literature.

A total of 29 refereed articles and 20 grey literature reports were thus included for final review and analysis (n = 49) (See Fig 3). In cases of discrepancy, consensus was agreed through discussion by two researchers (NW and SL) and review by two other researchers (NG and CH).

Data extraction and synthesis

Two researchers (NW and SL) extracted data from all included studies. Data extraction was initially attempted using a piloted form adapted from Renzaho and Mellor's food security

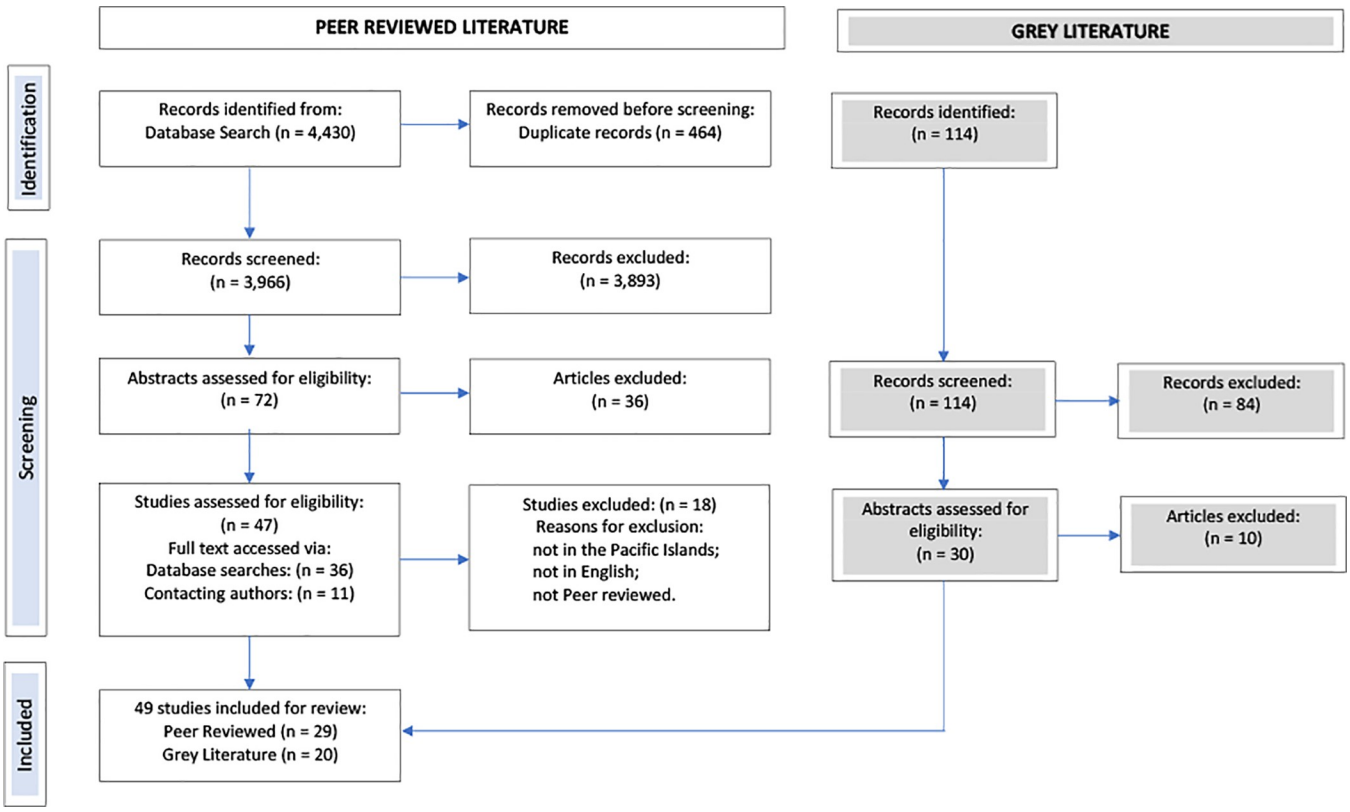

Fig 3. Study selection process. Source: Created by authors.

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framework, which focussed on their four pillars of food security: (i) food availability, (ii) food access, (iii) food utilisation and (iv) asset creation [29]. While this was a helpful starting point, these categories did not entirely fit with the data in the Pacific Islands where studies were often of a technical nature dealing with practice, and did not align analytically to the categories above. Instead, data were thematically analysed (CH and NG) using Braun and Clark's process of coding to develop relevant themes to summarise the common features of the literature [30].

Results

From the total of 29 articles and 20 reports included for the final scoping review, four main themes emerged, some of which overlapped, and which are listed below:

- Community adaptation, resilience, and crop diversification.
- Decreased availability of local foods and land.
- Changes in diet.
- Gender and agricultural production.

Community adaptation, resilience and crop diversification

Since the 1970s Pacific peoples have been increasingly integrated into global supply chains. This has brought benefits for information, education and health, however the relatively small population has meant limited industrialization and no economy of scale that might make a

PICT globally competitive. The vast distances across the Pacific means air transport and services in shipping are relatively expensive, while fuel for both cars (where roads exist) and boats is imported and costly. Villages away from roads are disadvantaged by high fuel prices, which results in a combination of static (or declining) production and high transport costs [31]. As a result, in many urban Pacific markets, food prices are extremely high. In Micronesia Connell argues that the small size of economies is a major factor affecting competitiveness, however it is not the only one—the cost of labour, credit and production all make it difficult for small producers in a global market who are subjected to free trade, so "household-based agriculturalists have simply withdrawn from commercial farming" [32]. This is not the case everywhere. In Solomon Islands some farmers have diversified and increased production of some crops to cater for growing urban populations [33].

Adaptation. Subsistence food production is practiced by over 80% of Pacific Islands' peoples. In 1986 Thompson found subsistence agriculture was still the dominant economic activity in PNG, and the foundation of nation's economy. Shifting cultivation for subsistence was practiced over less than 15% of the land surface of PNG. Village small holders were enthusiastic in their take up of fruits and vegetables for consumption and sale, indicating a willingness to engage in the cash economy, and the capacity to adapt to integrate into it [34]. On Bellona Island (Solomon Islands) a 2012 study found shifting agricultural cultivation had continued as a land use practice, and "remains crucial to the overall risk management strategy of the island". Shifting cultivation is an adaptation that delivers a reliable source of food supply that is sustainable, and other food needs are supplemented by imports. Notably, the period of time the land was fallow had actually increased, while the cropping frequency (i.e. the intensity of land use) was lower than it was in the 1960s [35].

Increasing populations in Melanesia add to food security concerns [36]. Peri-urban and adjacent areas proximate to large (40,000+) urban centres like Port Moresby, Noumea, Honiara, Suva, Port Vila, Nandi, Lae, Apia and Dededo, require fresh food, resulting in strong links between food production activities and income creation [34]. Urban Honiara (Solomon Islands) has limited employment options, leading to re-selling of produce being the only source of income for more than 80% of roadside vendors [37]. As not everyone has access to the large and usually crowded Honiara Central Market (HCM), roadside produce resellers/vendors play an important role in the dispersal of fresh produce through Honiara and its environs [33].

Adaptation is evident in Tarawa, Marshall Islands, where the successful 'banana circle' initiative composted existing organic material to increase soil fertility and grow crops—a low maintenance, low cost and culturally acceptable system that provides families with saleable products [38]. Adaptation can be seen in simple measures such as the adoption of technology (hoes, wheel-barrows), as well as inter-cropping/mixed cropping improvements, and the use of cover cropping and agro-forestry [36]. In Fiji the government has organised Farmer Field Days to allow exchange of information among farmers and the creation of cooperatives [39], while in Solomon Islands, the FAO has provided technical assistance to farmers to develop sustainable rice production to offset the cost of imports [40].

Resilience. A combination of factors including climate change [41] requires Pacific communities to develop strategies of resilience, including planting more reliable crops. Iese et al. [42] note that in both Polynesia and Micronesia varieties of sweet potato have proved to be increasingly popular, as farmers can harvest three crops a year. Sweet potato is the most important staple in terms of calories, and is widely available in the Pacific due to ". . .its ability to grow on both rich and poor sandy soils, its ability to grow non-seasonally in tropical regions, its good storage properties, its high yield per hectare, its demonstrated drought and salt tolerance, and its resistance to some pests and diseases" [42]. On Bellona (Solomon Islands) Mertz

et al. found farmers were growing more sweet potato than previously because it provides high yield after a relatively short fallow period, and requires less weeding than a crop of yam [35]. This versatility of sweet potato gives Pacific peoples access to food before, during and after natural disaster events.

Another form of resilience comes through innovation. In Solomon Islands, heavy rains create floodwaters that cut roads and bridges into the capital Honiara. Farmers on the Guadalcanal plains both east and west of Honiara produce around 80% of all produce sold at HCM [43,33], but during flood times they cannot get their produce to market easily. Misfortune for some presents opportunity for others. Small farmers from villages on offshore islands continue to transport their produce to HCM by boat during floods, which points to a capacity to diversify food supply systems to urban areas during times of disaster [44].

Crop diversification. Crop diversification ensures availability of food for farm-based families, and also supports food exchange. In 1983 the South Pacific Commission linked increased diversity in production with increased social, cultural, economic and political participation [45]. Sharing of knowledge can be a pathway to cultural wellbeing in Fiji, Cook Islands and Samoa, with protection of agricultural knowledge perceived as urgent in the light of decreased overall interest in the production and consumption of traditional crops [46].

A 1987 study of taro monoculture among the Mountain Ok of PNG noted the diversity of the larger system in which farmers participate is more important than the crops they plant [47], however in 1992 Shaw noted farmers in Tonga and Western Samoa demonstrated adaptability with both increased subsistence agricultural production and increased diversification—taro, sweet potato, cassava and yam, along with a range of vegetables, fruit, fish and livestock—which then formed the basis of subsistence systems [48]. A 2005 study in West New Britain (PNG) noted crops being grown between oil plantations and food gardens, which provided a source of additional income for households. Apart from their own food gardens, small farmers were mono-cropping peanuts and sweet potato for local market sale, along with "pineapples, pawpaw, watermelon and banana". Farmers also diversified into cash crops such as vanilla and betel nut, which need less land or labour than palm oil [49].

A PNG study from 2010–2012 found intercropping of coffee with food crops benefitted women by enhancing food security and cash incomes [50], and this trend holds more generally for the Pacific region. In Fiji, exotic specialist crops like turmeric and mango were being developed alongside micro-tourism ventures [51], while ni-Vanuatu could benefit from agro-ecological tourism which could both improve food security and livelihood outcomes [52]. A 2011 SARE study found integrated sustainable livestock and agriculture could work well together in Micronesia [53]. Both AusAID [54] and ACIAR [50] reports see the agricultural export sector as a key to diversifying incomes, while in Solomon Islands the Australian government's *Strongim Bisinis* (strengthening business) program promotes cocoa and coconut [7,33].

A 2012 study of small households in West New Britain found that when oil palm prices are high, engagement with the market actually declines, yet by maintaining food gardens, small holders reduce their vulnerability to fluctuating oil palm prices [55]. Despite population pressure, a 2018 study found small holders were able to grow sufficient food for their families by regularly selling surplus garden foods at local markets, and by consuming nutritionally rich foods. They also adopted the intercropping of oil palm into land previously reserved for food gardens [56].

Other adaptations are a result of unstable climate, with farmers in PNG, Fiji, Tonga, Kiribati and Nauru finding the intercropping of supplementary crops such as spinach, sugarcane, cabbage, tomatoes and spice plants with beet crops such as taro, cassava, sweet potato, and yams, can increase both diversity of foods and incomes [57].

Intercropping of coffee with fertilised short-rotation vegetable crops in the PNG highlands had promising results, recycling nutrients to develop sustainable production systems for both coffee and food through efficient use of land and nutrients [50]. In investigating Pacific Islands contract farming, an FAO report [58] also found diversification of income generation away from primary sector activities, indicating mixed farming. A 2015 Vanuatu study found high levels of food production were achieved with increased root crop plant density in very small plots, sometimes on marginal land [59]. Paulson and Rogers' (1997) work in Savaii, Western Samoa found many households were meeting their subsistence needs without undue stress due to the village social environment, with even less time directed toward agricultural production in 1995 than there had been in 1990, even though the nature and pace of social life was not substantially different [60].

Scarcity/Decreased availability of local food/land

The decreased availability of arable land through clearing, logging, or for use by plantations, affects the capacity of communities to support their food needs, while urbanisation creates a group of people who have moved from their villages of birth and who are thus reliant on the purchase (rather than the growth) of food to meet their needs. The literature shows PICTs are experiencing some scarcity in available arable land, a matter that has affected food production, and that a likely cause for this is population growth [61], although as Bourke (1989) noted [62], linkages drawn between increased population and decreased food production need also to include climatic factors such as drought. Climate change affects production through the extremes of cyclones and lower rainfall. For example, 2015's cyclone Pam in Vanuatu [63] caused immense damage to food supply, while higher salinity places stress on existing food supplies and requires adaptation [64–65].

MacCarthy's 2012 study of yam production in the Trobriand Islands of PNG found a decrease in yields due to shortened fallow periods, and poor soil conditions/reduced soil fertility. In this case, the lower yields meant that islanders previously known for their yam gardening were "travelling to outer islands in search of basic garden foods" [66]. Koczberski, Curry and Bue found vulnerable populations in urban and non-village rural areas [55]. These groups have limited and/or insecure access to land and income, and truncated social and kinship networks. Increasing numbers of people moving from poorly serviced rural areas to urban centres, and to more populous rural regions where employment opportunities are higher and services are generally better, results in a group of internal migrants who have no customary rights to land for food gardening, and who then need to buy food. Such people are vulnerable to sharp increases in food prices, especially imported foods (e.g., tinned food), which Sharma found was more common in urban diets than in rural diets [67].

A 2009 study on Tarawa (Kiribati) found the over dependence on donors for stock and tools is one of biggest challenges to sustain the home garden movement, while major issues affecting local food availability existed around: pests (such as crabs); a lack of supplies and tools; infertile soils; and unavailability of fresh water [38]. Also in Micronesia, Connell found increased food dependency on imported foods—especially rice, tinned fish, noodles and sugar—was accompanied by a decline in subsistence agriculture, and a change in farming food crops to cash crops. Food was increasingly being purchased, and other changes—"ageing farmers, inadequate prices and weak marketing structures, 'parcelisation' into tiny plots through inheritance, price fluctuations (especially for copra), 'modern' education and higher wages in the formal sector"—resulted in the conversion of agricultural land to other uses [32].

Further, Connell links migration, remittances, negative cultural attitudes to agricultural labour and imported foods to a decline in agricultural land usage in parts of Polynesia

(Tuamotus in French Polynesia, and Cook Islands), noting "agriculture is widely typified and derided as an activity of low status and prestige, especially for men". Yet he also notes Pacific communities elsewhere have retained and even attempted to revitalise their subsistence agricultural systems [32]. The FAO for example has been attempting to reverse negative cultural perceptions of farming by encouraging more young people to engage in agricultural production [68].

The changing climate of the Pacific plays a significant role in the production of local foods [69–70]). A 2008 FAO report on climate change notes changes in rainfall and water availability impacted food production of important crops in Marshall Islands [64]. In the Pacific more generally, increases in sea levels and extreme weather events such as droughts and cyclones have impacted soil salinity and freshwater availability that have further impaired food production [70–71].

While Melanesian states comprise the vast majority of the land area of the PICTs, there is in some parts a lack of arable land. Jones and Charlton [73] found Port Vila, Vanuatu generally had poor access to local foods and a consequent high dependence on expensive food imports. If residents of Port Vila were to achieve the internationally recommended intake of 400g of non-starchy fruits and vegetables (NSFV), it would cost them over 40% of the household food budget of the poorest families. As a result of high food cost and low availability, people turn to cheaper and less nutritious food imports. Other stresses on local food production are soil fertility and soil erosion, saltwater intrusion, invasive species, land availability, pests and diseases. A 2015 SPREP report found less land available due to coastal erosion, saltwater intrusion and increasing population, while increased numbers of pests and disease have led to a high incidence of whitefly, affecting banana, pawpaw, and fruit trees [74].

Overall, the literature suggests that there appears to be less arable land now available in the Pacific for food growing than in the past, and that for a mix of economic, cultural and convenience reasons, 'local' foods are giving way to cheaper and less nutritious imported foods that affects diet, as explained below.

Changes in diet

The Pacific has undergone a 'nutrition transition' where there has been an increased dependence on bulk imported processed foods [67,69,72,75,76] which are most often cheap, although due to distance, shipping costs and food type, some can be relatively expensive [77]. The weakened diversity of local food production in the Pacific and increased dependence on imported processed foods over the past few decades has resulted in increasing rates of non-communicable diseases (NCDs) such as obesity, diabetes, and heart disease [71,74,78,79]. Research suggests many reasons for this shift, including easy accessibility with increased availability of cheap, energy dense foods, income growth, urbanisation, climate change and various policies implemented by Pacific governments. The shift from traditional foods to imported foods commenced in the 1970s-1990s and is on-going, with more processed food and sugar in diets while local foods are mostly cooked for special occasions [32]. The dependence on imports is mainly on food items such as carbonated soft drinks, baked goods, vegetable oils, processed meats, noodles, rice, tinned fish and sweet biscuits.

The penetration of urban local markets by imported foods has resulted in the importation of cheap, poor-quality foods. In urban regions in particular the easy accessibility and availability of processed calorie-intense foods has increased people's dependence on them [67,69,70,73]. In contrast, rural populations continue to depend on yams, sweet potatoes, bananas and watermelon from their own gardens, and on local fisheries [72]. In the Commonwealth of the Northern Mariana Islands (CNMI), because imported foods were cheaper and

more easily available there was a decline in production and preservation of local foods [69]. In Vanuatu changes in dietary preferences were linked with high demographic pressures and less availability of land for production in urban centres [59], while in PNG and Tonga a per capita decline in food production has occurred, linked to both changing climate and increased food imports [67,71].

In 2013 the ADB reported the Pacific region's share of global food consumption was increasing, placing stress on local food supply [39], a trend that was also causing trade deficits through increased imports [78]. Foreign assistance in the form of food aid has been a contributing factor in the increase in imported foods, which have affected local consumption patterns [69,80].

A 1989 study on Saipan (CNMI) found that, in addition to the initial foreign assistance programme, changes in land tenure, nuclearisation of the household, changed labour patterns, greater cash income and the influence of Western education, values and preferences have influenced, and continue to influence, dietary habits [69]. In PNG, Allen, Bourke and Hide found that as the population increases, diet changes, and this transition is assisted by increased access to the market: there was consumption of high yield crops, as well as crops that grow in soil with low fertility (sweet potato), and importantly the sale of agricultural produce in order to gain money to buy imported foods like tinned meats or rice [76]. A similar trend was later found in Vanuatu [70] where increased income from sale of agricultural produce led to the increased purchasing of imported and local foods.

Westernized diets have comparatively high levels of fat, sugar and salt, with lower levels of fibre and complex carbohydrates. Shifting to such diets has been linked to increased prevalence of dental cavities, diabetes, hypertension, obesity and cardiovascular disease in the region. And once introduced foods become normalised in the Pacific diet, they remain, and continue to affect a PICTs balance of payments through imports. A 1986 follow-up survey of islanders on Saipan (CNMI)—occurring five years after a 1982 nutrition assistance program—found that the consumption of imported foods was significantly higher among program participants than among non-participants, and that this was linked to the decreased home production of fruits and vegetables [69].

Gender and agricultural production in the Pacific

Research on small holder agricultural production that includes gendered relations in its analysis has mostly been undertaken in PNG [49,55,56] Solomon Islands [33,37,43,44,81], and to a limited degree in Samoa [60]. There are four common findings across these Pacific Islands states. Firstly, both men and women play an important role in agricultural production and marketing of agricultural produce, however there is a gendered division of activities. In agricultural production, women and children tend to undertake labour intensive tasks such as garden maintenance and weeding, while men undertake sporadic strenuous work, such as clearing gardens and harvesting. Women dominate the marketing of agricultural production of surplus from subsistence agricultural farming and cash crops for domestic sale at local markets [33,37,43,55,60,81]. For example, in Solomon Islands, where approximately 80% of the population is involved in some form of agricultural production, women were 82.9% of vendors at the HCM [81] and importantly over 70% of all producer/vendors were women selling their own produce [33,43]. On palm oil plantations in New Britain gardening is a central component of the everyday lives of women, and women allocate more time to gardening than to palm oil, while men allocate equal time to gardening and working on the palm oil plantation [55].

Secondly, cash income from the sale of agricultural production at market by women provides important cash income for households and is essential to household income security. In

West New Britain (PNG), women's income from local marketing of garden foods was the most important source of household income after the sale of oil palm for small holders living on highly populated blocks and during periods of low palm oil processing [55–56]. In Solomon Islands, large council-run markets and private roadside markets in Honiara provide important income generation opportunities for women [33,37,43,81] who otherwise face limited employment options locally. Producer vendors can on average earn up to three times the daily minimum wage from their market selling [33]. Indeed, marketing was the only source of household income for more than 80% roadside vendors, who were predominantly women [37]. On Savo Island, Solomon Islands, some 35km northwest of Honiara, women make up most farmers and sellers, and their cash income from marketing fresh agricultural produce in Honiara was normally the only source of cash flow for their households, with earnings primarily spent on children's education, housing supplies, church activities, some imported food and community needs. Women also had primary control over how the income from marketing was managed [44].

Thirdly, engagement with the market economy and the introduction of export crops, as well as the sale of high value domestic cash crops (e.g., watermelon in Solomon Islands) has resulted in men taking ownership and authority over the most profitable agricultural income streams [33,56,81]. Notably in Solomon Islands this trend extended beyond the small holder production node of agricultural value chains to include activities along the chain, such as transportation of agricultural produce to market, that generated higher incomes for those involved [33,43]. In PNG the extension of Australian administrative control initially led to the end of tribal fighting, which allowed men to spend more time engaged in farming, and peace enabled safe access to gardens and markets for women who were able to sell surplus produce at market. However, this surplus was appropriated by 'big men'—non-hereditary 'achievement-orientated' leaders in most of Melanesia who by virtue of their proven abilities in "production, organization, politics or war" [82] exercise a high level of influence over the activities of the clan. In many villages in PNG, surplus was used to maintain the reproduction of a big-man's social group against other social groups, and to compete with the leading males of those groups through exchange [76].

Finally, subsistence farming plays an important role in household food security. In West New Britain, households residing on oil palm plantations rely heavily on food garden production for daily food intake, and this is especially so during periods of depressed oil palm prices when the existence of food gardens, mostly tended by women, is an important buffer against declining household incomes [55,56].

Women are important actors in addressing the central issues in food supply and food security in the Pacific, especially in the context of the growing food insecurity among Pacific Islands states due to changing consumption patterns, rapid urbanisation and the impacts of climate change. They play an important role in fresh food production and sale, however in doing so they face risks to their personal safety. For example, in PNG in the 1990s increasing robbery, theft and violence constrained the ability of women to reach their subsistence gardens safely, and they were at risk of sexual harassment or rape during travel [76]. In Solomon Islands, women have experienced overcrowding at market sites, poor water supply and sanitation, and endure violence, theft and intimidation and sexual harassment, factors exacerbated during stays at market of up to a week to sell their produce [33,43,44,81].

Discussion

Across the PICTs self-sufficient farmers who grow food on their own land (either held individually or in common with close family) remain the backbone of Pacific Islands food production.

As Bourke has noted, the maintenance of customary forms of land holding maintains a connection between a community and its land that is important for spiritual wellbeing [83].

Rural Pacific communities demonstrate a high degree of resilience to external shocks, however as this review has demonstrated, the nature of life in PICTs is changing, and Pacific ecosystems are becoming more fragile.

Reversing the trend towards the consumption of imported foods in highly urbanised areas will not be possible, however in most of Melanesia and in parts of Polynesia rural subsistence or semi-subsistence small holder farmers still constitute around 80% of the PICT population [2]. Here, small holder farmers are key to sustainable economic development and food security. Currently, small holder farmers produce the local foods that sustain their own diets, and they can sell surplus production of local foods to urban populations, which benefits their communities. We contend that donors could assist the governments of these larger PICTs to develop better infrastructure to support domestic agricultural production so as to provide sustainable and endogenous economic growth. Donors could assist by encouraging domestic production and domestic markets, helping to improve the efficiency of domestic agricultural production, distribution and exchange within the domestic market, and by supporting innovative technological solutions to problems of distribution that affect access to fresh produce in urban areas. These issues are interconnected, as seen below.

Adaptation

As the scoping review has revealed, Pacific diets have certainly been changing over the past 50 years, yet local foods still play a large part for many, either as staples or in ceremonies. Some 80% of Pacific peoples still grow much of their own food. The continued production in bulk of raw, low-cost foods is critical for continued food security in PICTs. Pacific islands peoples and communities have however demonstrated a capacity to adjust their farming practices quickly in response to changes in climate, natural disasters and to pressures such as population, urbanisation, changing diet and market opportunity. This adaptability can mean that different crops can be quickly taken up or set aside, and that new crops can be integrated into the farming practices, either for consumption or sale.

Supporting and stimulating domestic economies

Amidst climate change, neoliberal globalisation, urbanisation, land clearing and resource extraction, small holder farmers in PICTs continue to play a vital role in providing fresh produce that feeds domestic urban areas as well as rural households. In general, the domestic agricultural sector in PICTs provides employment opportunities and economic growth. Rather than concentrate on developing niche agricultural export crops that might benefit a fraction of small holder farmers, greater aid donor attention is warranted toward supporting ways in which small farmers can feed urban centres and rural areas. The likely increase in profits for sellers may assist in reversing the negative attitudes towards agriculture as an employment option that have emerged in some PICTs. Farmers feeding domestic populations can play a key role in sustainable food security, improved nutrition and create wealth. To do so may require both PICTs and donors to consider how improved domestic transport systems could assist in strengthening food security.

Infrastructure

Increased urbanisation creates opportunities for local small holder farmers to sell produce at domestic markets and roadside markets [37] through market gardening, however the further the point of origin of the produce from market, the less likely it is that there will be substantial

trade volume [33]. Indeed, distance reduces the variety of crops available at a market, with a large variety of fresh leafy green vegetables tending to come from areas closer to the market, while for reasons of post-harvest loss, a more limited selection of larger and more durable fruits and vegetables come from further away [31].

The lack of infrastructure throughout PICTs has been identified as causing bottlenecks that increase food wastage [31]. Improved access to fresh produce for urban populations can be created if donors and PICTs work together to better link areas of food production to food consumption. Aid donors already provide technical and infrastructure support through the reconstruction of roads and bridges after flooding, however, more could be done to mitigate problems of transport articulation and transport infrastructure. Any such changes would require significant local buy-in as roads usually run through customary land, and local agreement is required for any road upgrade.

Donors and governments of PICTs can also play a role in improving market infrastructure, including availability of clean water for washing food (including fish), cold storage at market, conditions for offloading produce at market, parking at market, covered market stalls, hygiene, and safety for vendors and their produce. Similarly, donors may wish to investigate technological innovations such as mobile phone applications designed to reduce post-harvest by linking producers and consumers resulting in more efficient produce collection and distribution.

Food and nutrition

The wider availability of cheap imported foods (in particular, noodles and biscuits) is the primary cause of increasing NCDs such as diabetes in PICTs. The influx of imported food has made "local food production more vulnerable and marginal", resulting in "loss of community and social cohesion" [32], a transition exacerbated by the presence of remittances, which also seems to be more acute in smaller PICTs and smaller communities. Affordable fresh local foods may reduce food imports. Concerted efforts by PICT governments to encourage local food consumption (for nutritional, economic and cultural reasons) may assist in reducing NCDs.

Gender and economic development

Most land in the Pacific Islands is held under customary title, often without any state record. Inheritance laws also vary widely with land gifted to male children (patrilineal) on some islands, and female children (matrilineal) on others. The relative absence of alienated land (either government owned or private) does not in and of itself create a problem in agricultural production by 'denying' economies of scale from emerging. Due to the nature of landholding, any "agricultural transformation" that linked the Pacific more closely with a global market economy would most likely increase PICT vulnerability to market shocks and precarity. On this point, Underhill and Singh-Peterson show that changes in international markets can have significant and detrimental effects on small island economies: in Tonga the collapse of the squash market in the late 1990s raised farmers' awareness of the risks of over dependency on one crop and led to increased horticultural diversification [5].

With the FAO declaring 2019–2028 as the decade of family farming, there are several implications for gender that would support the achievement of SDG2. As UN Women notes, women comprise 75–90% of market vendors across PICTs [8], and women in PICTs control the family finances. The sale of surplus at market by women, or the growth of food specifically for market, appears to be a very important source of family income, yet it is one that is heavily affected by transport costs. Agriculture remains highly gendered in Melanesia, with women doing most of the field labour, gathering and selling, although the transport of food produce

appears to be an area that is male dominated. Studies across the Pacific have generally not focussed on this issue. Indeed, much of the academic focus on agricultural production and its sale tends to be technical, which is a significant oversight as historically there is a relationship between cultural identity, associated customs and traditions across the Pacific [66]. This emphasis on the technical ignores the interplay between 'social production' and 'subsistence production' [77], the ways in which modernity and the market economy have brought changes to agricultural food systems, and how these changes have gendered dynamics [84,85]. More research is required to fully understand the role of gender in land ownership and agricultural production in PICTs.

Conclusion

Urbanisation, population growth, a decrease in arable land and climate change are likely to continue to affect food security in the PICTs. Small holder farmers in PICTs face climatic, price and financial risks that endanger already fragile food production systems, yet they have demonstrated resilience and adaptation. They play an important role in feeding urban centres and rural areas. Donors working with PICTs to support better integration of domestic agricultural producers could help to improve small holder access to markets, and therefore national and perhaps even regional food security. This would have the added benefit of encouraging economic development for women and employment for young people. While Pacific communities have a history of adapting to adversity, the suggestions above can support the synergy identified by the FAO [20]—that family farming supports all the SDGs, and that the SDGs support family farming.

Supporting information

S1 Appendix. Literature review study inclusions.
(DOCX)

S2 Appendix. Scoping Review Themes.
(DOCX)

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