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REVIEW

How membership of a farmer organization can support farmers in adapting to climate change in the Pacific Island region

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Abstract

Climate projections for the Pacific Island region serve to emphasize the climate unpredictability, variability and intensity that farmers will have to adapt to in the future. The impact that climate change is having on agriculture in the Pacific is evident from the data around agriculture loss and damage from extreme weather events such as flooding and cyclones. It is clear that food systems will have to be resilient and farmers will have to adapt, if food security in the region is not to be seriously threatened. The factors considered as essential for building adaptive capacity are: (a) social capital; (b) ability of communities to engage effectively with external agents; (c) access to knowledge including how knowledge is generated, shared and exchanged; (d) merging of local and external knowledge; (e) space for farmers to interact, communicate, experiment and learn from each other; (f) trust in the adaptation measure(s)being promoted; (g) effective capacity building; (h) decentralized research; and (i) supportive policy. This article explores these factors and proposes that membership of a farmer organization (FO) provides an enabling platform for the effective and efficient delivery of these conditions, thereby providing farmers with the tools essential for adaptation to a changing climate. Examples illustrating how farmers around the Pacific Island region are working together to put in place measures that will strengthen the resilience of their farming systems are provided from national and regional farmer organizations in the region.

Keywords: farmer organizations, adaptation, Pacific Islands, climate change, food security, grassroots, family farmers

Review methodology

Information was obtained from the following sources:

1. Pacific Islands Farmer Organization Network based in Fiji and Hawaii – an umbrella organization for national FOs. PIFON began informally operating in 2008 and registered as a not-for-profit company in 2013. Its reach covers 13 Pacific Island countries, 30 national FOs and 95,000 farmer livelihoods. I work with this organization.
2. CABI Direct using the search terms farmer organization, climate change, Pacific Islands
3. Google Scholar using the search terms farmer organization, climate change, Pacific Islands.
4. PAIS – Pacific Agriculture Information System using the search terms farmer organization, climate change, Pacific Islands.
5. Personal contacts – I worked for 22 years in the Pacific Islands region, based for 8 years in Samoa and 14 years in Fiji. Towards the end of my time in Fiji I produced a book Taylor *et al*. (2016).

Pacific farmers and agriculture

Pacific Island farmers have a deep experience in managing the effects of climate variability on agriculture, largely due to the region's exposure to the El Niño Southern Oscillation (ENSO). Traditional farming systems, which centre on agroecological approaches, have been relatively resilient against external shocks and have helped to maintain food security. Local knowledge sustained over generations, through a range of traditional and cultural practices, has been the foundation of this resilience, and community cooperation and collaboration have provided the social safety net (Sisifa *et al*., 2016; McLeod *et al*., 2018; McLeod *et al*., 2019).

Today, however, these resilient traditional farming systems are less common, and as a result, farming systems are now more vulnerable to climate change. Other pressures exist such as an expanding population, growing urbanization, labour migration, land degradation, such as soil nutrient depletion and soil loss, deforestation, loss of biodiversity, depletion of freshwater resources through saline incursions and contamination from urban, agricultural and industrial sources, and inadequate investment

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(Barnett, 2019). Further, changing aspirations and value systems have contributed to an under-valuing of traditional food systems resulting in a lack of interest from youth to engage in agriculture (Thaman, 1982; SPC, 2010; FAO, 2015; Sisifa *et al*., 2016) (Fig. 1).

Climate change adds another dimension to these pressures, that of extreme variability and unpredictability. Climate change is affecting, and will continue to affect food systems in the Pacific Island region, including the supply of food from agriculture and fisheries, the ability of countries to import food (because of increasing costs, shortages in supply and export bans (Sharma, 2023)), distribution systems, and the ability of households to purchase and utilize food (Bell *et al*., 2016; Taylor *et al*., 2016).

Impact of climate change on agriculture in the Pacific

CURRENT AND PROJECTED CLIMATE CHANGE

Climate projections are available for most of the Pacific Islands. The 'Next Generation Climate Projections for the Western Tropical Pacific', (RCCAP, n.d.) launched in October 2021, concluded that temperatures have increased, sea level has risen, and cyclones have become less frequent but more intense. Projections confirm continued warming, and increasing frequency of extreme weather, such as rainfall intensity. Cyclone impacts are likely to increase as a result of the projected increase in average cyclone intensity combined with sea level rise and increased heavy rainfall intensity. Sea level rise is occurring at a faster rate in the region (approximate increase of 4 mm annually in certain regions, which is higher than the worldwide average of 3.4 mm per year (WMO, 2022). A decrease in the return times for extreme weather events (the period of time that passes between extreme events) will affect the ability of food systems to recover, and changes in extremes will be compounded by changes in mean sea-level, temperature, and rainfall, posing significant challenges for Pacific farmers (Handmer *et al*., 2012).

Fig. 1. Indigenous root and nut crops proven to have more climate resilience than many introduced crops.

The ENSO has been influencing climate in the Pacific Islands for centuries, and remains a major source of climate variability, affecting rainfall, cyclone frequency and intensity and occurrence of extreme events (Murphy and Power, 2014; Lough *et al*., 2016). How climate change will affect ENSO in the future is a common question in the region. Cai *et al.* (2023) concluded that after 1960, there is very strong variability in the ENSO and this strong variability has contributed to more extreme and frequent droughts, floods, heatwaves, bushfires and storms around the world. Projections for the future suggest more intense and frequent El Niño and La Niña events and also more frequent swings from a strong El Niño to a strong La Niña the following year (Cai, 2023). These projections serve to emphasize the climate unpredictability, variability and intensity that Pacific farmers will have to adapt in the future.

Managing climate change in the Pacific Island region is made more complicated by the weather pattern differences that exist between the islands and within the islands. As noted by Lebot (2013), the temperature and rainfall can change significantly between different locations, for example, between the windward and leeward sides of the same island. This variation in weather patterns within and between the islands reinforces the importance of research that is relevant to the local context, that is, decentralized research.

CURRENT IMPACT OF CLIMATE CHANGE ON AGRICULTURE IN PACIFIC

Cyclones are a significant cause of lost agricultural production, for example, Tropical Cyclone (TC) Winston (2016) caused over US$200 million in crop damage and loss in Fiji (Mansur *et al*., 2017). TC Pam devastated Vanuatu in 2015 and caused losses and damages to the agriculture sector valued at US$56.5 million (Government of Vanuatu, 2015). The waves and strong winds from TC Pam destroyed about 30–90% of crops on many islands of Tuvalu with the economic impact estimated to be 25% of Tuvalu's projected GDP in 2015 (Katea, 2016). The drought which followed TC Pam destroyed vegetation across Vanuatu, and affected food security in PNG and the Republic of the Marshall Islands (Iese *et al*., 2021). Drought presents problems to agriculture everywhere in the region, particularly given the lack of irrigation (Fig. 2).

Flooding in river catchments threatens food production. Flooding in Guadalcanal Island, Solomon Islands (2014), affected over 9000 households, destroying more than 75% of household food gardens (Government of the Solomon Islands, 2014). TC Cody (January 2022), brought significant rain affecting the whole of Fiji. An initial assessment estimated damages to the agricultural sector at over US$4 million, and more than US$1.3 million in relief was ultimately paid in assistance to the farmers (Duncan *et al*., 2022).

Saltwater intrusion affects crop production on low-lying islands, either directly by impacting crop growth and/or indirectly through its impact on groundwater reserves (Tekinene, 2014). In Tonga, wells located on the low-lying coastal areas showed increasing salinity because of saltwater intrusion (Government of Tonga, 2012). Several low-lying islands in the Solomon Islands and Micronesia have already been lost – including Kale and Rapita in the northern Solomon Islands – and more are experiencing severe erosion due to sea-level rise (Thomas *et al*., 2020).

Urgency of the situation

'Adaptation opportunities will be reduced and the risks of unavoidable damages increased (medium confidence) in vulnerable regions, including small islands, that are projected to experience higher multiple inter-related climate risks at 1.5°C global warming compared to today, with risks increasing further with warming of 2°C (high confidence).' IPCC (2018)

Fig. 2. A papaya farm devastated by extreme rain events, waterlogging and disease pressure.

There is no doubt that climate change is already affecting Pacific farmers. Current global projections suggest that there is 66% likelihood that the annual average near-surface global temperature between 2023 and 2027 will be more than 1.5°C above pre-industrial levels for at least 1 year. There is 98% likelihood that at least one of the next 5 years, and the 5-year period as a whole, will be the warmest on record (WMO, 2024). This surge in temperatures is fuelled by greenhouse gas emissions (GHG) and a naturally occurring El Niño event. IPCC's Sixth Assessment Report (AR6) states that unless there are immediate, rapid and large-scale reductions in GHG emissions, limiting warming to close to 1.5°C or even 2°C will be beyond reach (IPCC, 2021).

Strengthening the resilience of food production systems to these projected changes is vitally important – and not just resilience to short-term shocks but an enduring resilience that will be able to absorb the extremes of climate variability as well as the long-term changes, such as an increase in mean temperature. The challenge is to support and enable farmers to continuously adapt their farming practices to unpredictably changing environmental conditions. An important part of this challenge will be to identify and predict where adaptation limits are likely to occur and who is most likely to be affected, to enable better planning for climate impacts (Dow *et al*., 2013; McLeod *et al*., 2019).

FACTORS THAT FAVOUR SUCCESSFUL CLIMATE CHANGE ADAPTATION BY FARMERS

Family farms (FAO and IFAD, 2019) are increasingly being acknowledged as critical to food security and nutrition around the globe. The United Nations Decade of Family Farming 2019–2028 seeks to place family farming at the centre of national public policies and investments (FAO and IFAD, 2019). It is vital therefore that these family farms – which are crucial global assets – are supported in their efforts to improve the resilience of their farming systems to enable adaptation to a changing climate. Farmer organizations are considered to be an effective means of supporting family farms (Thierry, 2023).

Resilience and adaptive capacity are closely linked. In general, resilience refers to ‘the ability of a system to absorb disturbance and reorganize while undergoing changes so as to still retain essentially the same function, structure, identity and feedbacks’ (Walker *et al*., 2004). Resilience is therefore considered as essential to strengthening the sustainability of food systems which is necessary if the increasing complexity and uncertainty associated with climate change is to be managed. At the farm level, resilience refers to the ability of farms to adapt to climatic, social and market shocks. Farmer adaptive capacity is therefore a prerequisite for building farm resilience to climate change and is linked to increasing the options for managing climate change and improving decision making under the uncertainty of climate change (Taylor *et al*., 2016: McLeod *et al*., 2019; Kangogo *et al*., 2020).

Various studies have considered what factors influence adaptive capacity. In the application of the Pacific Adaptive Capacity Analysis Framework (PACAF), social capital was identified as a critical adaptive capacity determinant, with leadership, collective action and engaging effectively with external agents as the most important (USP, 2011). The ability to engage effectively with external agents in sourcing and using adaptation resources (such as finance and technology) in a way that responds to their own immediate and future needs is an essential determinant of adaptive capacity, especially with the influx of adaptation investment in the Pacific (Taylor *et al*., 2016).

Access to knowledge is considered vital in building adaptive capacity. How knowledge is generated, shared and exchanged is important, and learning platforms through participatory action research (PAR), farmer field schools and community-based initiatives have been found to be particularly effective. Merging of local and external knowledge is critical for widening and diversifying farmers’ knowledge base (Silici *et al*., 2021; Hainzer *et al*., 2022). Pelling *et al*. (2008) also emphasized the important role of organizational structures for improving adaptive capacity in that they provide space for farmers to interact, communicate, experiment and learn from each other. Cinner *et al*. (2018) identified: (a) the flexibility to change strategies; (b) the ability to organize and act collectively; (c) learning to recognize and respond to change; and (d) the agency to determine when and how to change, as important assets in building adaptive capacity for resilience.

McNamara *et al*. (2022) discuss the challenges for adaptation in the Pacific Islands and put forward four mutually reinforcing adaptation pathways that could lead to more equitable, sustainable, and effective adaptation futures. They stress the importance of locally led adaptation, so that local knowledge, local resources and local realities are central to any adaptation measure or strategy that is implemented. Locally appropriate alternative entry points for adaptation are also considered important, including the use of traditional forms of governance.

Cvitanovic *et al*. (2016) in their study of climate adaptation in the Pacific Islands emphasized the importance of adaptation science, local social networks, key actors (influential and trusted individuals) and relevant forms of knowledge exchange in overcoming the barriers to climate adaptation. Their findings suggested that the trust is best developed through participatory research approaches, which allow for the inclusion of traditional knowledge into research.

Membership of a farmer organization (FO) provides a platform which supports many of the factors identified as critical for influencing adaptive capacity, such as, access to knowledge, technology etc. and the space for farmers to interact (Tompkins, 2005; Kangogo *et al*., 2020; Barokatuminalloh and Setiarso, 2022; Ma *et al*., 2023; White *et al*., 2023). In its 2008 World Development Report, the World Bank identified producer organizations as a ‘fundamental building block’ of its agriculture-for-development agenda, and prioritized support to enhance producer organizations’ performance as a key strategy to increase the productivity and sustainability of smallholder farming (Oxfam, 2008).

FO MEMBERSHIP SUPPORTS FARMERS TO BETTER ADAPT TO CLIMATE CHANGE

Factors essential for enabling successful adaptation have been identified through numerous studies and have been discussed in Section ‘Factors that favour successful climate change adaptation by farmers’. These include: (a) social capital – an ability to organize and act collectively; (b) ability of communities to engage effectively with external agents; (c) access to knowledge including how knowledge is generated, shared and exchanged; (d) merging of local and external knowledge; (e) space for farmers to interact, communicate, experiment and learn from each other; (f) trust in the adaptation measure(s)being promoted; (g) effective capacity building; (h) decentralized research; and (i) supportive policy (Fig. 3).

Membership of a FO provides an enabling platform and mechanism for all of these factors. FOs are good sources of information, and they provide a space in which farmers can interact, generating and sharing knowledge (Vermeulan and Wynte, 2014; Bingen and Simpson, 2015: PIFON, 2018; Bizikova *et al*., 2020; Kangogo *et al*., 2020). FOs can facilitate farmer exchange programmes across countries and regions so that less experienced farmers can learn from those with more experience. This farmer-to-farmer learning can be very beneficial if farmers have to diversify in order to adapt to climate change, that is, adopt crops and farming systems that are new to them. Learning from farmers with experience of these crops can be very effective in the transfer of knowledge and skills (Robinson, 2020).

FOs can be the mechanism for the effective communication of external knowledge and the integration of local knowledge. Knowledge based on local practices may not be sufficient to elicit more transformative adaptation actions which are likely to be needed in the long-term management of climate change. Technical training and skills transfer are also critical enabling factors for improving the uptake of adaptation (Frank and Penrose Buckley, 2012; Taylor *et al*., 2016; McLeod *et al*., 2019; Race *et al*., 2023).

Innovation in agriculture is clearly an important response for effective and equitable climate change adaptation and mitigation (Borda-Rodriguez and Vicari, 2015). Innovation relies on access to finance, information and other resources, which can be acquired through participation in FOs, especially for resource-constrained farmers. Not all individuals will be innovators, hence the need for platforms and mechanisms that enable successful innovations to be shared more widely. FOs facilitate experimentation and in so doing support innovation and a more proactive approach to climate change challenges, essential for managing the unpredictability of climate change (Kangogo *et al*., 2020). A diversity of knowledge available from different sources (farmers, scientists, advisory services, agricultural companies) is often a prerequisite for innovation. FOs can bring together these actors, acting as ‘innovation intermediaries’ (Iyabano *et al*., 2022).

Decentralization allows for policies and practices specific to the local environmental needs, which are essential for effective climate change adaptation (McLeod *et al*., 2019; Fischer, 2021; Carter and Hollinsworth, 2022; McNamara *et al*., 2022). It is supportive of innovation, and also of outcomes that are more useful at the local level (McGregor *et al*., 2016; van Zonneveld *et al*., 2020). It is an approach that promotes the use of local knowledge, leads to more relevant research questions and ensures that the results and skills are shared with those who will use them. Importantly with a decentralized approach to research, farmers are doing the research themselves – taking their ideas, combining and integrating them with good science, while at the same time, tailoring the technologies and methods to meet their needs (Stice and McGregor, 2016; Ensor and de Bruin, 2022).

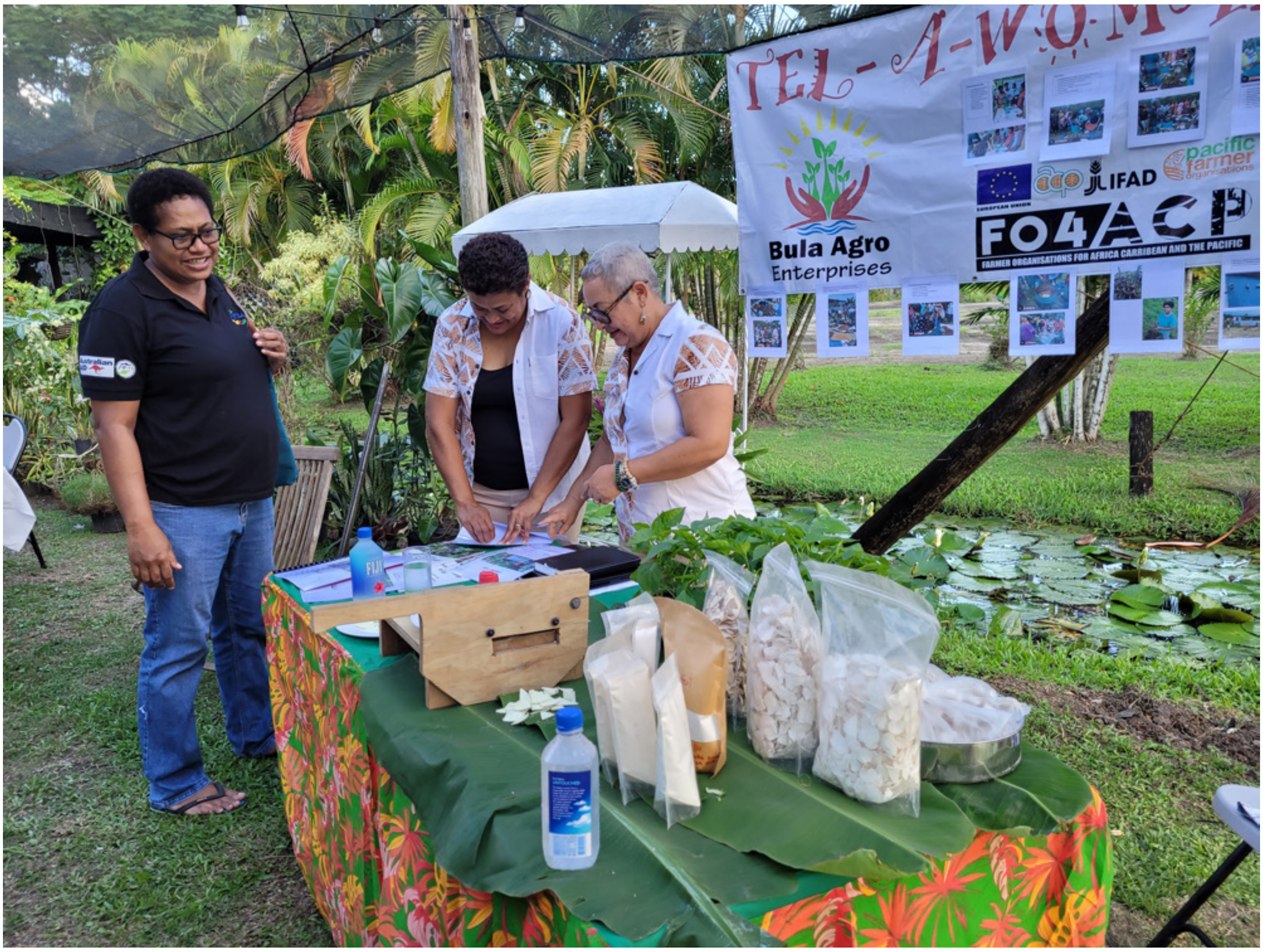

Fig. 3. Bula Agro 'Tel-A-Woman' program training in backyard gardening.

FOs are best placed to implement decentralized research (PAPP, n.d.), especially in regions such as the Pacific Islands, where membership covers farmer associations from different islands within an archipelago, and from islands dispersed across the vast Pacific ocean (Chand and Kumar, 2019; Norton and Alwang, 2020). With the implementation of decentralized research, there is an opportunity to evaluate crops and systems across the diverse ecosystems found in the region (Palanivel and Shah, 2021). Decentralized research paves the way for participatory research and extension which are considered the major drivers behind agricultural innovation, mainly because of the multi-directional flow of knowledge and technology between farmers, extension providers and researchers (NRI, 2010), ensuring that appropriate and relevant research is conducted and then effectively 'translated' and disseminated among farmers (Beyer, 2015). The policy brief 'Agricultural Research and Farmer Organizations in the Pacific' (PIFON, n.d.-b) summarizes the advantages of the decentralized research model for Pacific Island farmers, emphasizing how it is an approach that allows for the efficient collection of diverse and widespread data, which in turn leads to higher farmer uptake (Fig. 4).

Additionally, FOs can facilitate the marketing of farm produce, which can give farmers the opportunity to access more lucrative markets, thereby generating improved revenues which can be reinvested in adaptation measures. Economies of scale may also support investment in communal resources, such as the commercial hot water dipping treatment available to Fiji papaya exporters through the Nature's Way Cooperative (NWC) (see Section 'Case studies illustrating how FOs can support farmers in adapting to climate change through improving the resilience of farming systems and value chains, and increasing market opportunities'). Investing in storage, transport and processing facilities can add value to their products and, with access to the right market information, can enable farmers to wait for better prices rather than selling to the first buyer (Frank and Penrose Buckley, 2012; Bizikova *et al*., 2020; Kangogo *et al*., 2020).

FOs can also assist farmers in accessing resources from governments, development agencies and private sector (Bizikova *et al*., 2020; Othman *et al*., 2020). Members of FOs may also enjoy significantly greater access to services owing to the cost savings that service providers enjoy by working with large groups including access to financial services such as credit and insurance institutions. Some FOs can support their members directly with access to financial capital (Frank and Penrose Buckley, 2012).

The ability to plan ahead is an essential characteristic of successful adaptation. Strong, forward-looking decision making from FOs will support their members to adapt successfully (Frank and Penrose Buckley, 2012). Further, participation in decision making within an FO can encourage local ownership and support community empowerment which all work together to strengthen trust in the decisions made and their consequences (Ma *et al*., 2023).

A supportive and enabling policy is vital for effective climate change adaptation. FOs can support farmers to be advocates for policy change and through their greater collective voice, are better placed to bring about policy change. FOs can lobby for the needs and preferences of farmers with evidence based on local experiential knowledge. For example, they can survey members to assess how a specific policy will impact livelihoods and/or carry out financial

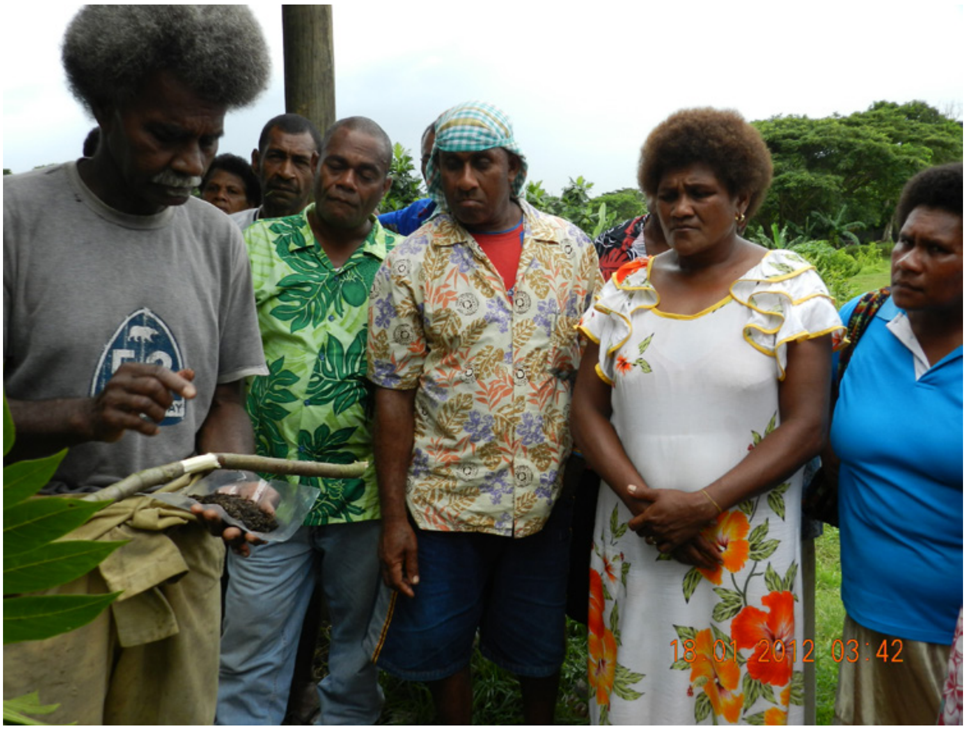

Fig. 4. Farmers helping farmers in marcotting of breadfruit.

analysis to show the impact in economic terms, and then provide this evidence to the policy makers (PIFON, 2018; Bizikova *et al*., 2020; Iyabano *et al*., 2022).

CASE STUDIES ILLUSTRATING HOW FOS CAN SUPPORT FARMERS IN ADAPTING TO CLIMATE CHANGE THROUGH IMPROVING THE RESILIENCE OF FARMING SYSTEMS AND VALUE CHAINS, AND INCREASING MARKET OPPORTUNITIES

In the Pacific Island region, the Pacific Island Farmers Organization Network (PIFON, 2020a) serves as an umbrella organization for national FOs. PIFON began informally operating in 2008 and registered as a not-for-profit company in 2013. Its reach covers 13 Pacific Island countries, 30 national FOs and 95,000 farmer livelihoods. PIFON's mission is to make Pacific Islands' FOs more vibrant, viable and sustainable organizations. PIFON has been hugely successful in organizing farmer-to-farmer learning, for example: (a) the first Pacific Farmers Open Pollinated Seed Learning Exchange (2016), which involved 60 farmers from Samoa, Tonga, Vanuatu, Timor-Leste, Fiji, PNG and the Solomon Islands (PIFON, 2016); (b) farmer-to-farmer exchange programme in Vanuatu (2017) where farmers visited and inspected various agriculture and agro-tourism productions streams (PIANGO, 2017); and (c) Farmers Forum and Farmer to Farmer Learning Exchange (2017) (APFP, n.d.) – the latter, according to the feedback received, was the most favoured part of the Farmers Forum, where farmers learned from other farmers (Fig. 5).

Climate models suggest that breadfruit will grow well across the tropics for many decades to come. Planting more breadfruit trees could significantly contribute to food security (McGregor *et al*., 2016; Yang *et al*., 2022). PIFON has been supporting breadfruit farmers in the Pacific (PIFON, n.d.-a). Farmer-led trials evaluating the performance of trees derived from different propagation types have resulted in a package of best practices for mass propagation of breadfruit. In addition, data collection from farmer-led trials on breadfruit intercropping systems has identified crops that work well in providing an initial cash flow from a breadfruit orchard. Through this work farmer-owned demonstration orchards are now coming into production some 18 months ahead of expectations, greatly improving the expected viability of breadfruit as a sustainable, commercial crop (APFF, 2018).

The Nature's Way Cooperative (NWC), Fiji, a member of PIFON works directly with 140 members, made up of growers and exporters, for all applied research work. NWC have achieved a number of major successes using this model including: (a) the establishment of a certified producer's scheme for Fiji Red papaya; (b) investment in a commercial hot water dipping treatment available to Fiji papaya exporters through NWC (potential to save the industry FJD2mn); and (c) development of technologies supporting sea freight of papaya from Fiji to New Zealand. Research findings indicate a 50% saving in freight costs with no reduction in fruit quality (NWC, n.d.). Much of the NWC applied research work on papaya was carried out under the Fiji Papaya Project (FPP) funded by the Australian Centre for International Agricultural Research (Clarke and Powell, 2022). NWC has recently begun processing fruits into value-added products as part of key plans to assist members, reduce post-harvest losses and promote consumption of local fruits (PIFON, 2020b). Best practice recommendations include selection of 'seed trees' based on performance under local conditions; bulking of seed stocks to quickly recover from natural disasters, and research into pre- and post-cyclone farm activities, such as defoliation, ratooning and sunburn protection (PIFON, n.d.-c).

NWC have also been the key in developing best practice for producing healthy planting material – an essential first step for sustainable, resilient farming – including developing disaster mitigation strategies for nurseries. Farmers are given training in establishing disaster-ready nurseries, including the use of containers for seedling storage as a response to cyclones (Tora *et al*., 2022). Availability of and access to seed can be a challenge in the Pacific Island region, especially in remote areas, yet a secure seed supply is vitally important for farmers if they are to manage climate change and disaster impacts. In response to this need, PIFON has provided training for its members on open-pollinated and hybrid seed production (PIFON, n.d.-c).

Fig. 5. Participants at the Tutu Rural Training centre learn about propagation and breadfruit agroforestry.

In Samoa, the Samoa Farmers Association (SFA) has been involved in subsector consultations to discuss the challenges facing the agriculture sector from climate change. Stakeholders, experts, and SFA members identified strategies and actions to build resilience and enhance the productivity and profitability of the crop subsector (Ariu, 2023).

Diversification, such as the development of alternative markets, is an important adaptation strategy. In an effort to establish an off-season pineapple production SFA arranged technical exchanges with the Fiji farmer organization, Tei Tei Taveuni. Despite only a limited number of farmers engaging in off-season production practices, pineapple is now available nearly all year round in selected outlets (PIFON, 2020c).

The Tutu Rural Training Centre (TRTC) (Tutu, 2023) and TeiTei Taveuni (2023) in Fiji are foundation members of PIFON and have been actively involved in farmer-to-farmer exchanges throughout the region. In an effort to address problems with decreasing fertility affecting taro and kava production in Fiji's Cakaudrove Province farmers cleared new forest areas for planting, clearly a move that was unsustainable. However, farmers, after being involved in trials conducted by the two FOs, are now exploring agroforestry initiatives, including the use of nitrogen-fixing *Mucuna pruriens*. The involvement of the two FOs was a significant factor in the uptake of the agroforestry initiatives. The positive results from the trials are now being disseminated to farmers across Fiji and the region through farmer-to-farmer exchanges organized through PIFON. Agroforestry increases adaptive capacity, reduces vulnerability, and thus helps farmers reduce climate risk (Quandt *et al*., 2023)

Jiwaka Youth in Agriculture Association (Papua New Guinea) formed as a result of a training event in Fiji on off-season cropping of fruit and vegetables, such as capsicum, watermelon, papaya, and cabbage. The training highlighted the importance of diversification as an adaptation strategy and the potential of off-season production and marketing. The association has grown to a membership of 250 and have contracts for the supply of capsicum and watermelon. The success of the Association has helped the young farmers to build proper houses for their families and to raise the profile and status of youth farmers (PIFON, 2020e).

In Vanuatu, collaboration between the Vanuatu Farm Support Association (FSA) (PIFON, 2020d) and Vanuatu Agricultural Research Centre (VARTC) saw the distribution of different taro and yam varieties to 10 villages in different locations. Two years after distribution, monitoring of the diversity in the villages showed an 86% gain in yam diversity and a 61% gain in taro diversity. Importantly, this gain in 'new' varieties was not associated with the loss of traditional varieties (Camus and Lebot, 2010). Without the support of the FSA the improved diversity available from VARTC would not have made it into farmers' fields. Enriching farmers' varietal portfolios strengthens the resilience of their food production systems. Improving agricultural biodiversity is seen as underpinning resilient farm ecosystems (Frison *et al.*, 2011).

Conclusion

FOs can play an increasingly important role in supporting farmers to adapt to a changing climate through facilitating information sharing and learning, promoting sustainable agricultural practices and tools, and strengthening policy advocacy and development. Importantly, they facilitate locally led adaptation, so that local knowledge, local resources and local realities are central to any adaptation measure or strategy that is implemented. Effectively addressing climate change in a region as diverse as the Pacific Islands require a focus on local conditions. Through a regional FO, such as PIFON, adaptation measures can be evaluated in other localities, and best practices scaled up, enabling a portfolio of adaptation measures to be established that work across a range of different environments.

Despite the successes of FOs in the Pacific and elsewhere, continued and strengthened support for FOs is necessary so as to enhance their effectiveness and sustainability, and to enable efficient and effective delivery of the key services necessary to build farmers' adaptive capacity. Governments and development partners must acknowledge the central role of farmers and FOs in addressing climate change and ensure that FOs are involved in the setting and delivery of agricultural research priorities so that farmers' needs are met. Financial support is vital, including proportional access to climate funds. Partnerships with FOs should be established to address the knowledge gaps around adaptation to a changing climate, including understanding of how farmers can continuously adapt their farming practices to unpredictably changing environmental conditions and the limits to adaptation. Governments, specifically, can provide support for FOs by providing enabling policy, regulatory and legal frameworks for FO operation which aim to enhance service delivery and strengthen the impact of FOs.

CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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AUTHOR CONTRIBUTIONS

Kyle Stice conceptualized the review, provided information and images, and reviewed the article. Mary Taylor carried out the research and the writing.

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