pacific farmer organisations

Role of Farmer Organisations in Climate Change Adaptation

About Pacific Farmer Organisations

Pacific Farmers Organisation (PFO) is the umbrella body for national farmer organisations in the Pacific Island Countries and Territories (PICT's). Agriculture is the main livelihood of the majority (typically 70%+) of the Pacific Islands population. Farmer organisations play a critical role in supporting small farmers to connect, influence, and access information and technologies to improve livelihoods. PFO is a key partner in supporting farmers and rural communities to respond to the challenges of climate change.

PFO is a vibrant and growing network of national farmer organisations that are supporting improved livelihoods for their members and rural communities generally. PFO began operating in 2008 comprising a small group of Farmer organisations (FO) in five countries, and following its legal establishment in 2013, it has grown to embrace 30 member organisations] and over 95,000 farming households (55% are women farmers) in 12 PICT's (Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, New Caledonia, Papua New Guinea, Samoa, Solomon Islands, Timor Leste, Tonga, and Vanuatu) and has member FOs in Hawaii (United States). PFO's Secretariat is based in Fiji with a satellite office in Hawaii.

About Farmers Organisations for Africa, Caribbean and the Pacific (FO4ACP)

With an implementation period of 54 months, the Farmers Organisations for Africa, Caribbean and the Pacific (FO4ACP) is expected to directly benefit 150,000 farmers in the (Pacific) region.
The Program is a joint partnership between the European Union, the African, Caribbean and Pacific Group of States, the International Fund for Agricultural Development and the Pacific Island Farmers Organisations Network.

Acknowledgements

This publication was prepared by Kyle Stice and Dr. Mary Taylor with technical inputs from Ian Kennedy, Tony Jansen and Angela Birch. The publication draws heavily on the contributions from Pacific Farmer Organisation members across numerous regional events. A number of organisations and projects also contributed to this publication through research activities, case studies and write ups, including: the Farmer-led Research and Innovation (FORI) project and the Pacific Islands Rural and Agriculture Stimulus Facility (PIRAS) project. Partners include the International Fund for Agricultural Development, the European Union, African, Caribbean, and Pacific Group of States (ACP), the Australian Government Department of Foreign Affairs and Trade, and Asia Farmers Association (AFA).

Produced for publication by Pacific Farmer Organisations with funding assistance provided by the Farmers Organisations for Africa, Caribbean and the Pacific (FO4ACP).

Cover Photo caption: *Turmeric is cultivated in the Sigatoka Valley of Fiji due to its market demand and ability to grow under high temperatures and moderate drought conditions.*

1.0 Pacific farmers and agriculture

Pacific Island people have a deep experience in coping with the effects of climate variability on agriculture, driven largely by the region's exposure to the vagaries of the El Niño Southern Oscillation (ENSO). Traditional farming systems, which centre on agroecological approaches, have demonstrated some resilience against external shocks and 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 has enabled effective adaptation. Community cooperation and collaboration have provided the social safety net.

Today, however, the more resilient food systems of the past are less common and as a result, food systems are more vulnerable to climate change. Further, this situation is exacerbated by pressures from an expanding population, growing urbanisation, 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. Changing aspirations and value systems have contributed to an under-valuing of traditional food systems and agriculture resulting in a lack of interest from youth to engage in agriculture.

Climate change adds another dimension to these pressures and despite all the climate models and projections, the main message around climate change is one 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), distribution systems, and the ability of households to purchase and utilize food. The unprecedented rate at which the global climate is now changing is not within the realms of experience of Pacific farmers. As such, local knowledge may not be sufficient to bring about the level of adaptation required to effectively manage climate change. Bridging local and external knowledge is therefore critical because it widens the farmers' knowledge base thereby supporting a more proactive approach to adaptation.

Indigenous root and nut crops such as these being sold in the Honiara Municipal Market are proven to more much more resilient to climate extremes than many other introduced crops.

[1] *https://www.aljazeera.com/economy/2023/8/16/how-indias-ban-on-some-rice-exports-is-ricocheting-around-the-world*

2.0 Impact of climate change on agriculture in the Pacific

2.1 Projected climate change impact for the Pacific and impact on Pacific Island crops

Climate projections are available for most of the Pacific Islands. Key messages from the 'Next Generation Climate Projections for the Western Tropical Pacific', launched in October 2021 include:

- Temperatures have increased, sea level has risen, and cyclones have become less frequent but more intense.
- Observed rainfall trends are not significant due to large natural variability driven by the ENSO.
- Further warming is projected, reaching around 0.7°C by 2030, relative to 1986-2005, regardless of the greenhouse gas (GHG) emission scenario. By 2050, the warming is around 0.8°C for a low emission scenario (RCP2.6) and around 1.5°C for a high emission scenario (RCP8.5). By 2070, it's around 0.8°C (RCP2.6) to 2.2°C (RCP8.5).
- Future rainfall changes have large uncertainty. The central estimate of projected changes is close to zero percent in countries south of latitude 10°S, with increases between latitudes 10°S and 10°N.
- Sea level will continue to rise. By 2030, the increase is about 0.09 to 0.18 metres, relative to 1986-2005, regardless of the GHG emission scenario. By 2050, the increase is around 0.17-0.30 metres for a low emission scenario (RCP2.6) and around 0.20 to 0.36 metres for a high emission scenario (RCP8.5). By 2070, it's around 0.24 to 0.43 metres for RCP2.6 and 0.33 to 0.63 metres for RCP8.5.
- Heavy rainfall intensity will increase.
- Fewer tropical cyclones are projected, but their average intensity could change by -5 to +10% for a 2°C global warming.
- The projected increase in average cyclone intensity, combined with sea level rise and increased heavy rainfall intensity, would increase cyclone impacts.

The ENSO has been influencing climate in Pacific Islands for centuries, and to this day remains a major source of climate variability. The main effects of the ENSO cycle are: (a) changes in rainfall seasonality; (b) occurrence of localised droughts and floods; (c) changes in the frequency, strength and location of tropical cyclones; (d) extreme high tides that result in saltwater intrusion which damages crops in low-lying areas; and (e) widespread frosts at higher altitudes in Papua New Guinea (PNG). How climate change will affect ENSO in the future is a common question — will future changes in the cycle become weaker or stronger? Cai et al. (2023) concluded that there is very strong variability in the ENSO after 1960 and that 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. These projections serve to emphasize the climate unpredictability, variability and intensity that farmers will have to adapt to in the future.

[2] *https://www.rccap.org/climate-change-update-for-the-pacific/*
[3] *https://www.csiro.au/en/news/all/articles/2023/may/climate-change-affecting-el-nino*

Tilapia farmers in Fiji face shortened seasonings as threats from flash flooding and extreme rainfall events increase.

A decrease in the return times for extreme weather events will be a critical factor in the ability of food systems to recover. These changes in extremes will be compounded by changes in mean sea-level, temperature, and rainfall, posing significant challenges for Pacific Island farmers.

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, for example, the archipelagos of Vanuatu and the Solomon 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. Ideally, regional- to local- scale projections of climate variables, such as seasonal temperatures, seasonal rainfall, and frequency of both temperature and rainfall extremes are key requirements in understanding the potential impacts of climate variability on agricultural productivity. This variation in weather patterns within and between the islands reinforces the importance of research that is relevant to the local context, that is, decentralised research.

Staple food crops grown in the Pacific Islands include bananas, breadfruit, sweet potato, taro, yams cassava, coconuts, cocoyam, giant taro and swamp taro. Wheat flour and rice are also important staples, but are almost entirely imported. Cacao, coconut, coffee, palm oil and sugar are the main export crops and there is increasing production of horticultural crops, such as papaya.

[4] *The period of time that passes between separate extreme weather events*

Breadfruit is a staple food crop in the Pacific, sold each week at the Nadi Market, Nadi, Fiji.

For most staples, increases in extreme weather events are likely to have greater impact than changes in temperature in the short-to-medium term (2030—2050). More frequent and more intense rainfall will test the skills of farmers in those countries where rainfall is already high, especially for crops sensitive to waterlogging, such as sweet potato. Excessively high soil moisture, particularly during 6—10 weeks after planting, reduces tuber yield and has been a major cause of food shortages in the PNG highlands (Bourke 1988). Possible changes in mean rainfall will vary from increases to decreases therefore farmers need to plan for the impacts of both wetter and drier conditions.

High temperatures could also affect the formation of sweet potato and yam, and increase the risk of pests and diseases, for example, enabling diseases to expand into areas that are currently unaffected. 30°C is the optimum temperature for taro, therefore temperature increases of 2°C and beyond could impact on production, and similarly with the other edible aroids, possibly with the exception of swamp taro. Increasing night-time temperature is of particular relevance for many crops, for example, rice, fruit and vegetables.

Beyond 2050, the negative effects of climate change on the local staples are expected to become much more pronounced, especially if global emissions continue to track the high-emission scenarios.

Negative impacts on production have been assessed as very high for rice; high for taro, swamp taro and domesticated yams; and moderate to high for sweet potato. By contrast, the impact on cassava, island cabbage (aibika, bele) and banana has been assessed as low to moderate, and low impact is predicted for cocoyam, giant taro, wild yams and breadfruit (McGregor et al. 2016a). Table 1, Annex 1 provides more detail on the impact of climate change for each crop.

The production of taro is threatened by changing rainfall patterns and waterlogging.

The impacts on livestock are variable. Indigenous, locally adapted breeds can be more resilient, while introduced breeds may be more vulnerable. Poultry, an important food source, are particularly vulnerable to projected temperature shifts (Lisson et al. 2016).

Of the major export crops that are grown for sale (cash crops), coffee is projected to be the most susceptible to global warming, with yields expected to fall significantly by 2050 in current production areas, mainly due to increased temperature in the uplands of PNG.

Most cash crops are vulnerable to extreme weather events, which account for many production losses across the region. High winds from more intense tropical cyclones have a significant impact on crops such as bananas and breadfruit. High wind speeds are a significant threat to coconut palms, especially older palms, which make up a major proportion of many existing plantations. Sugar cane will be affected by flooding. Cacao production in PNG and the Solomon Islands is also likely to be hit hard, though opportunities exist for countries, such as Vanuatu and Fiji, where a warming temperature could increase cacao production (McGregor et al. 2016b).

Despite the challenges outlined above that will have to be addressed by farmers when growing Pacific staples, climate change impact studies suggest that global staples such as rice and wheat will be more negatively affected than Pacific staples in a changing climate (Adhikari et al. 2015; McGregor et al. 2016).

With this in mind, enhancing the resilience and expanding the production of Pacific staples, rather than relying on imported staples, such as wheat and rice, will support regional and national food security and livelihoods in a changing climate. Further, focusing efforts on increasing the sustainable production of staple food crops would also confer nutritional advantages. The increase in non-communicable diseases (NCDs) is closely connected to the region's reliance on imported foods, such as wheat and rice. Rice imports have increased by 50% between 1995 and 2018. Comparatively, wheat and wheat flour has experienced a 2.5-fold increase in net imports (Brewer et al. 2023). Reliance on these imports also leaves the Pacific region vulnerable to global shocks as seen by the price rises caused by COVID-19 supply chain challenges and the Ukraine-Russia conflict (Brewer and Andrew, 2022).

Banana and coconut being sold at a municipal market, two common staple crops with proven resilience to climate extremes.

The risks posed to global rice and wheat production by climate change, linked with increasing demand for these basic foods by the expanding world population, are likely to lead to less secure and more costly supplies of imported staples in the region. In contrast, the climate resilience of some Pacific staple food crops — such as breadfruit, cassava and giant taro — provides opportunities to soften the potential effects of climate change on food security and livelihoods across the region, and make some progress on alleviating NCDs — a win-win situation.

2.2 Current impact of climate change on small farmers in Pacific

Pacific Island populations are already experiencing climate-related impacts such as rising sea levels, storm surges, cyclones, and extreme weather events. There is also evidence that temperatures are rising at a rate that was not anticipated to occur until 2030-2040, indicating the accelerated impacts of medium-term climate change, occurring before the projected timeframe (Handmer and Nalau, 2019).

In a study on the impact of climate change on Bellona Atoll, Solomon Islands, survey respondents suggested that the temperature change observed over the past 30 years has impacted food crops in several ways. All of the groups (100%) identified wilting, early maturity, change in taste and decline in yields as the most significant impacts on crops due to temperature increase. The groups also observed an increase in rainfall, which was connected with severe rotting, negative effects on flowering/fruiting, and a loss of some crop varieties (Iese et al. 2015).

The increased risk of flooding in river catchments also threatens food production, for example, flooding in Honiara, Solomon Islands, in 2014, affected over 9000 households in Guadalcanal Island, destroying more than 75% of household food gardens in these areas (Reliefweb, 2018). Tropical Cyclone (TC) Cody in Fiji (January 2022), brought significant rain which affected the whole of Fiji — there was extensive flooding in the Western division, and some communities in the Central and Eastern divisions were also affected. Water levels were slow to subside in some areas due to the saturated soil. An initial assessment estimated damages to the agricultural sector at over USD4 million, and more than USD1.3 million in relief was ultimately paid in assistance to the farmers[5].

[5] *https://www.climatechange.ai/blog/2022-09-06-grants-fiji-flood*

Shortage of water and degradation of agricultural lands is one factor contributing to the relocation of some Solomon Islands communities from a number of provinces to Honiara. 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).

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

Saltwater intrusion affects crop production on low-lying islands directly - increases in salinity are reportedly impacting the growth of giant swamp taro in Tuvalu (Tekinene 2014) - and indirectly through its impact on groundwater reserves - studies in Tonga showed increasing salinity of wells located on the low-lying coastal areas because of saltwater intrusion (Government of Tonga 2012).

Cyclones are a significant cause of lost agricultural production, for example, TC Winston (2016) caused over USD100 million in crop losses in Fiji. TC Pam devastated Vanuatu in 2015 and caused losses and damages to the agriculture sector valued at USD56.5 million (Government of Vanuatu 2015a). The waves and strong winds from TC Pam destroyed about 30—90% of crops on many islands of Tuvalu. The economic impacts of TC Pam were estimated to be 25% of Tuvalu's projected GDP in 2015 (Katea 2016).

The drought which followed TC Pam destroyed vegetation across Vanuatu, and the lack of foliage worsened the impacts of the drought on soils and crops, reducing food security. The drought also 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.

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 2.0°C (high confidence).' IPCC (2018)

There is no doubt that climate change is already affecting Pacific farmers. Current 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 one year. There is 98% likelihood that at least one of the next five years, and the five-year period as a whole, will be the warmest on record[6]. This surge in temperatures is fuelled by GHG emissions 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[7].

Strengthening the resilience[8] 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. This unpredictability is compounded by the difficulty in accurately projecting weather patterns at the local level.

The capacity of farmers and institutions to respond to the new and emerging impacts of climate change can be constrained by lack of access to information and improved technologies, as well as inadequate support mechanisms for promoting the assimilation of new knowledge. Various knowledge gaps exist, including understanding how farmers can continuously adapt their farming practices to a climate that is changing and unpredictable. Identifying and filling these knowledge gaps are essential in order to put in place policies that support farms facing unpredictable climate conditions.

There will be limits to adaptation, and assessments are required that 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). Current assessments tend to concentrate on quantifying biophysical and socio-economic benefits but do not make the link to management and policy options that would allow for the implementation of local adaptation options (Hills et al. 2013).

2.3 Factors/conditions that favour successful climate change adaptation by farmers.

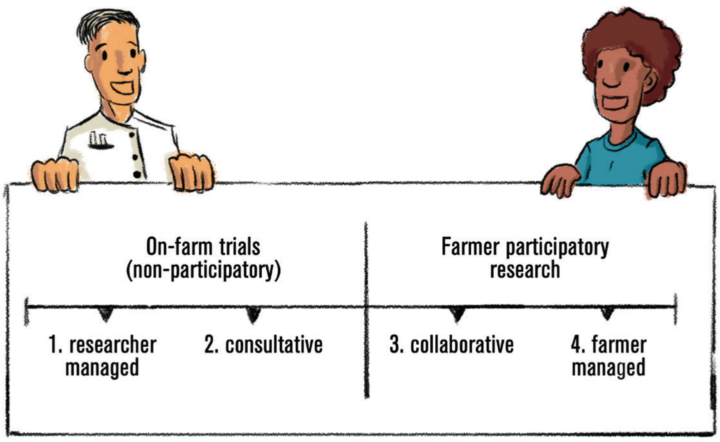
Family farms[9] are increasingly being acknowledged as critical to food security and nutrition around the globe. The United Nations General Assembly declared in 2019 the United Nations Decade for Family Farming 2019-2028 (UNDFF) as a central instrument to unlock its transformative potential[10]. It is vital therefore that these family farms — which are crucial global assets - are supported in their efforts to improve the resilience of their food systems to enable adaptation to a changing climate.

[6] https://public.wmo.int/en/media/press-release/global-temperatures-set-reach-new-records-next-five-years
[7] https://www.ipcc.ch/2021/08/09/ar6-wg1-20210809-pr/
[8] Increasing resilience can be achieved by reducing exposure to risk, reducing sensitivity and strengthening adaptive capacity.
[9] Family Farming (including all family-based agricultural activities) is a means of organizing agricultural, forestry, fisheries, pastoral & aquaculture production that is managed & operated by a family, & is predominantly reliant on the family labour of both women & men. https://www.fao.org/3/ca4672en/ca4672en.pdf
[10] United Nations Decade for Family Farming 2019-2028 (UNDFF) https://www.fao.org/family-farming-decade/home/en/

Members of Vanuatu farmer organisation, Farm Support Association, amend their soil with organic matter produced by a compost pile on their family farm.

Resilience and adaptive capacity are closely linked. In general, resilience refers to 'the ability of a system to absorb disturbance and reorganise 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.

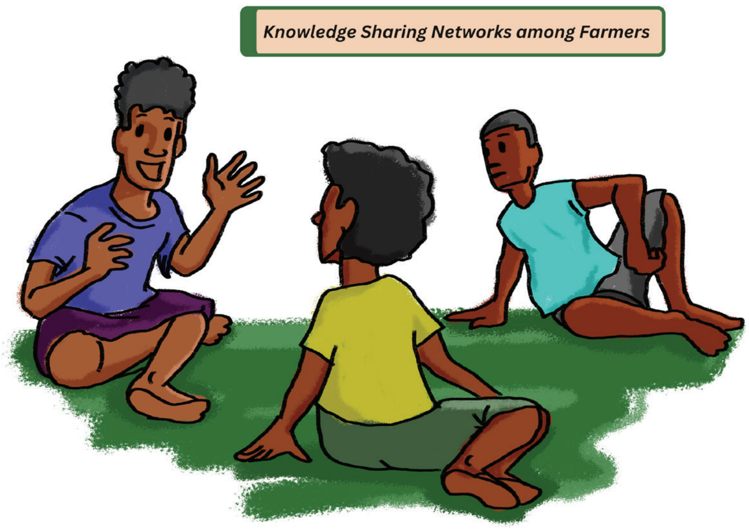
Various studies have considered what factors influence adaptive capacity. In the application of the Pacific Adaptive Capacity Analysis Framework (PACAF) social capital was identified as a critical adaptive capacity determinant, with leadership, collective action and engaging effectively with external agents as the most important. 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).



Farmer-led Participatory Research

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 and for enabling 'proactive' adaptation alongside the more typical 'reactive' adaptation (Silici et al. 2021). Pelling et al. (2008) also emphasized the important role of organisational 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 propose four mutually reinforcing adaptation pathways that could result in more equitable, sustainable, and impactful 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. Finally, they emphasize the need to share all adaptation experiences, even those that are not successful on the basis that they could reveal unexpected or novel outcomes that might not be captured in the evaluation metrics used for that project. This approach would also remove/weaken any negativity that can be associated with adaptation experiences that 'fail', thereby minimising the possibility that 'failures' can result in undermining the willingness of farmers to become involved in future adaptation measures and/or to take risks with innovation.

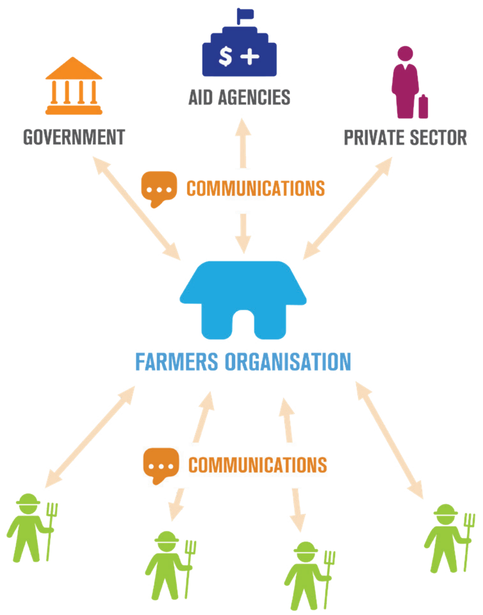


Farmer-led Participatory Research

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 (i.e. influential and trusted individuals) and relevant forms of knowledge exchange in overcoming the barriers to climate adaptation. Their findings suggested that the development of trust is best nurtured through participatory research approaches, which allow for the inclusion of traditional knowledge into research. Membership of a farmer organisation (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. FOs act as sources of information, learning platforms and social support that farmers can rely on when trying to manage climate change (Tompkins, 2005). In its 2008 World Development Report, the World Bank identified producer organisations as a 'fundamental building block' of its agriculture-for-development agenda, and prioritised support to enhance producer organisations' performance as a key strategy to increase the productivity and sustainability of smallholder farming (Oxfam, 2008).

3.0 What are the benefits for farmers if they belong to a Farmer Organisation?

Farmer Organisations (FOs) are a mechanism for reaching farmers at scale, facilitating information sharing and learning, promoting sustainable agricultural practices and tools, and strengthening policy advocacy and development. Further, FOs can provide farmers with a voice in regional and international forums which can result in securing donor support. With effective local networking FOs can share, learn and innovate, with effective organisation they can act as aggregators (in order to better obtain finance, access markets and benefit from higher prices), and with an effective voice, they can influence policy makers[12]. A recent scoping review of the contributions of FOs to smallholder agriculture in sub-Sahara and India grouped the observed FO impacts into six categories: income, yield, production quality, environment, empowerment and food security (Bizikova et al. 2020).



The Pacific Island Farmers Organisation Network (PIFON) serves as an umbrella organisation 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 organisations. (https://pacificfarmers.com)

FOs involved in agricultural research utilise a decentralised research model which has proven to be more efficient and effective at meeting the specific needs of farmers compared to the traditional centralised research model found across the Pacific. The decentralised research approach takes into account the diverse ecological conditions that prevail in most island countries, where soils and climatic conditions can vary greatly over short distances. The policy brief 'Agricultural Research and Farmer Organisations in the Pacific'[13] highlights a number of case studies where FO involvement has resulted in successful agricultural research. FOs are flexible in responding to the complexity and dynamics of farmers' needs, creating linkages with other actors/stakeholders, as illustrated by the numerous successes of Nature's Way Cooperative (NWC), Fiji, (see Box NWC).

[12] *https://ccafs.cgiar.org/news/effective-farmers-confronting-climate-change*
[13] *https://pacificfarmers.com/wp-content/uploads/2018/12/Farmers-Having-Their-Say.pdf*

3.1 Key areas/issues where FO membership/participation should enable farmers to better adapt to climate change

PIFON have been hugely successful in organizing farmer-to-farmer learning, e.g: (a) the first Pacific Farmers Open Pollinated Seed Learning Exchange (2016) involved 60 farmers from Samoa, Tonga, Vanuatu, Timor -Leste, Fiji, PNG & Solomon Islands; (b) farmer to farmer exchange programme in Vanuatu (2017) where farmers visited & inspected various agriculture & agro tourism productions streams; & (c) Farmers Forum & Farmer to Farmer Learning Exchange (2017) — the latter, according to the feedback received, was the most favoured part of the Farmers Forum, where farmers are taught & learn from other farmers.

Nature's Way Cooperative, Fiji, (NWC)
The numerous successes of NWC - formed in 1996 to undertake mandatory quarantine treatment on behalf of the fresh fruit and vegetable industry - include the establishment of a certified producer's scheme for Fiji Red papaya, investment in a commercial hot water dipping treatment available to Fiji papaya exporters through NWC (potential to save the industry FJD2mn), and 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.

As discussed in Section 4.0., farmer adaptive capacity is a prerequisite for building farm resilience to climate change and is associated with expanding the options that are available to farmers for managing climate change and improving decision-making under uncertainty.

Several factors, that are essential for enabling successful adaptation, have been identified through numerous studies and have been discussed in 2.3. 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 (see Box for examples of PIFON success in this area); (f) trust in the adaptation measure(s) being promoted; (g) effective capacity building; (h) decentralised research; and (i) supportive policy.

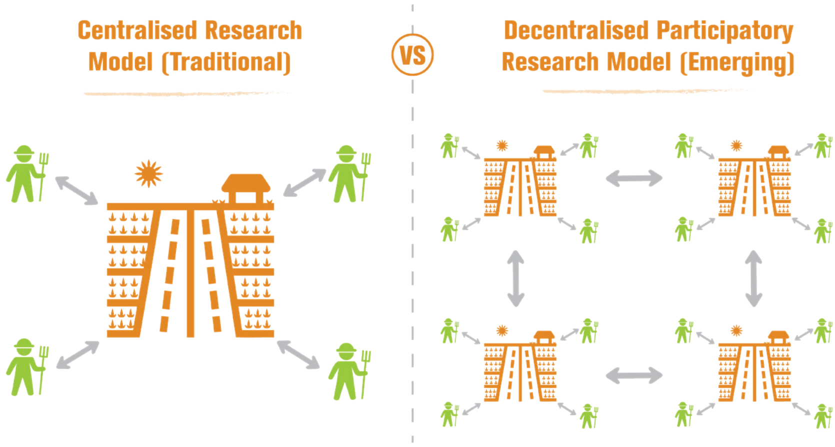
Membership of a FO provides an enabling platform and mechanism for all of these factors. FOs are good sources of information, as well as providing learning platforms and social support, that farmers can rely on when dealing with climate change. Further they provide a space in which farmers can interact, generating and sharing knowledge. 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, take on crops and farming systems that are new to them but have been used in other countries/regions.

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. Merging local and external knowledge is considered critical as it broadens the farmers' knowledge base and in doing so helps in nurturing more forward-looking/proactive considerations. Technical training and skills transfer are also critical enabling factors for improving the uptake of adaptation.

Farmer-led Participatory Research

Innovation in agriculture is clearly an important response for effective and equitable climate change adaptation and mitigation. 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. 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' (Aboubakar et al., 2022).

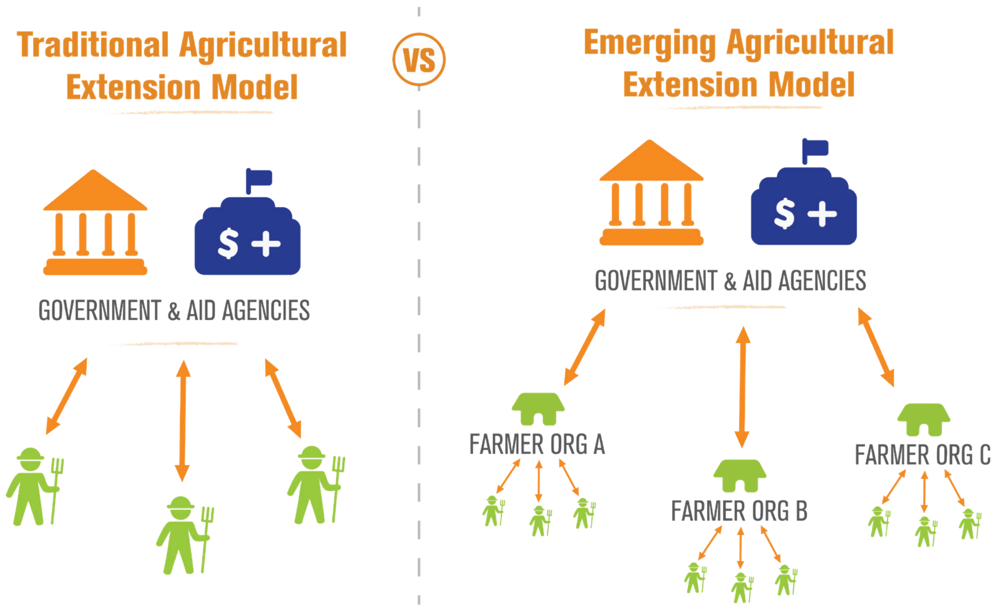
Decentralization allows for policies and practices specific to the local environmental needs, which are essential for effective climate change adaptation. It is supportive of innovation, and also of outcomes that are more useful at the local level. It is an approach that promotes the use of local knowledge, leads to more relevant research questions, and ensures that the results and skills are shared with those who will use them. Importantly with a decentralised 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. FOs are best placed to implement decentralised research, especially in regions such as the Pacific Islands, where membership covers farmer associations from different islands. Participatory research and extension 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), which ensures that appropriate and relevant research is conducted and then effectively 'translated' and disseminated amongst farmers.



The policy brief 'Agricultural Research and Farmer Organizations in the Pacific'[14] summarises the advantages of the decentralised research model for Pacific Island farmers, emphasising how it is an approach that allows for the efficient collection of diverse and widespread data, which in turn leads to higher farmer uptake. The case studies described in Section 3.2 illustrate the gains that can be achieved with decentralised research, as does the work of NWC (see box, P7). The development, growth and uptake of commercial breadfruit orchards in some countries, for example, Fiji, is testament to the work done by farmers in their fields. Farmer-led trials evaluating the performance of trees derived from different propagation types have enabled the establishment of a package of best practices for mass propagation of breadfruit. Similarly 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.

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 NWC (see box, P7). 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.

FOs can also assist farmers in accessing resources from governments, development agencies and private sector. 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 Buckley, 2012).



The ability to plan ahead is an essential characteristic of successful adaptation. Membership of a FO can help to increase the planning horizon for individual farmers, depending on the organisation's access to knowledge and information, their links into wider networks through which this information is accessed, and their capacity to plan effectively. Strong, forward-looking decision-making from FOs will support their members to adapt successfully (Frank and Buckley, 2012). Further, participation in decision-making within a FO can encourage local ownership and support community empowerment which all work together to strengthen trust in the decisions made and their consequences.

[14] https://pacificfarmers.com/wp-content/uploads/2016/03/Agricultural-Research-and-Farmer-Organisations-in-the-Pacific-1.pdf

A supportive and enabling policy is vital for effective climate change adaptation. FOs can support farmers to be advocates for policy change (see Farmers Having Their Say)[15] and through their greater collective voice, are better placed to bring about policy change. They 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 analysis to show the impact in economic terms, and then provide this evidence to the policy-makers.

In conclusion, FOs are critical in providing the farmer with learning, legitimacy, governance, diffusion of innovation, and information necessary for adaptation to changes.

3.2 Case studies/evidence from the region, and globally, which illustrate how FOs can support farmers in adapting to climate change.

The Tutu Rural Training Centre (TRTC) and TeiTei Taveuni are foundation members of PIFON and have been actively involved in farmer-to-farmer exchanges throughout the region. Problems with decreasing fertility affecting taro and kava production in Fiji's Cakaudrove Province saw planting being shifted unsustainably into new forest areas. However, farmers are now exploring agroforestry[16] initiatives, including the use of nitrogen-fixing Mucuna, after being involved in trials conducted by the two FOs. Uptake of the agroforestry initiatives was greatly facilitated by the two FOs. These messages are now being spread to other farmers in Fiji and the region through farmer-to-farmer exchanges organised through PIFON.

Fr. Petero Matairatu, Director, Tutu Rural Training Centre explains how new agroforestry planting practices have increased the Training Centre's agricultural productivity.

[15] *Farmers Having Their Say; Pacific Island Farmers Organisation Network 2018 https://pacificfarmers.com/wp-content/uploads/2018/12/Farmers-Having-Their-Say.pdf*

[16] *Agroforestry increases adaptive capacity, reduces vulnerability, and thus helps farmers reduce climate risk (Quandt et al. 2023)*

In Vanuatu, collaboration between the Vanuatu Farm Support Association (FSA) 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 per cent gain in yam diversity and a 61 per cent gain in taro diversity. Importantly this gain in 'new' varieties was not associated with the loss of traditional varieties. Without the support of the FSA the improved diversity [17] available from VARTC would not have made it into farmers' fields.

Climate change is posing an increasingly serious threat to coffee. In recent years, unusual and erratic climate conditions have seen considerable economic losses in many coffee-producing countries. In Uganda, members of the Gumutindo Coffee Co-operative Enterprise have benefitted from access to information through training sessions, use of new technology and tools, access to credit — individually farmers would not have had this level of access. Farmers have received advice and training in a number of key resilience strategies, and, as a result, feel that they have a greater understanding of climate change and ways in which to manage the impacts on coffee production (Frank and Buckley, 2012).

Kenyan potato farming also highlights the importance of membership of FOs in strengthening farm resilience. Members are able to access inputs and services which can help in adapting to climate change, including from private businesses, non-governmental organisations (NGOs) and government. In Meru, small village-level farmer groups merged to form a potato co-operative, which provides member farmers with access to credit and certified potato seed in varieties demanded by specific buyers. This facilitated access to technology, inputs and services is supporting farmers in managing the impact of climate change on their potato crops (Kangogo et al. 2020).

On-farm diversification is a key component of a range of climate change adaptation practices and technologies. However, how and when to diversify, can be a risky business, especially for poorer farmers. FOs can facilitate on-farm diversification by working with farmers in a participatory way so as to prioritize their constraints, concerns, aspirations, and opportunities for on-farm diversification. In Central America, Mexico, and Cuba agro-ecological farmer-to-farmer networks have reached ten-thousands of farmers in their promotion of diversification, including the introduction of cover crops and green manures, such as Mucuna and jack bean, which reduce the sensitivity of farm soils and productivity to hurricane and flooding exposure (van Zonneveld et al. 2020).

[17] *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).*

4.0 Way forward

4.1 Government and Development Partners.

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, to enable efficient and effective delivery of the key services necessary to build farmers' adaptive capacity.
Governments and development partners should:

- **Recognise and acknowledge the central role of farmers and FOs in addressing climate change**, ensuring food security and protecting biodiversity, and support their efforts at adaptation and capacity development.
- **Ensure an enabling policy environment and support the participation of farmers and FOs in climate and biodiversity policy-making** at national, regional and global levels, as well as in the debate on the structure of the Loss and Damage Fund. Inclusive and equitable policies and their implementation with dedicated funds are essential in overcoming barriers such as gender disparities[18].
- **Acknowledge the crucial role of youth in sustaining a resilient agriculture sector**, in particular small farms, and ensure that this is reflected in public policies, programmes and funding allocation. Young farmers are the bridge between traditional, local knowledge and innovation.
- **Ensure proportional access to climate funds** by acknowledging the damaging impact of climate change on farming systems and at the same time, the crucial role that small farms play in providing food security[19].
- **Pursue partnerships with FOs to address the knowledge gaps related to the impact of climate change on agriculture** through decentralised research. Knowledge gaps can refer to a lack of data concerning the impact of climate change on a specific crop (for example, local fruits and vegetables) or the lack of actionable knowledge indicating a need to repackage existing knowledge. By developing partnerships with FOs, the benefits from funding can be maximised because FOs can reach more farmers and scaling-up is optimised (Stibbe et al., 2019).
- **Involve FOs in the setting of agricultural research priorities to ensure farmer needs are met.** To have a positive impact, research needs to involve farmers at all stages: in determining needs, identifying problems and opportunities, designing and testing new possibilities, sharing results, and assessing the way the research is done and the results shared.
- **Work with FOs to improve overall understanding of how farmers can continuously adapt their farming practices to unpredictably changing environmental conditions** in order so that policies can be developed which support farmers as they face unpredictable climatic conditions. Farmers' capacity to choose effective adaptation options is influenced by a wide range of factors, including farm size, income, access to markets, access to climate information and extension, etc. Institutional, policy, and technology support should acknowledge the diversity of adaptation strategies and be sufficiently dynamic to make a timely response to changing needs. Policies to address constraints (e.g., lack of secure land tenure, lack of capital to innovate) to adoption of climate-smart practices will be needed. Improved understanding will enable more confident decision-making and better allocation of resources.

[18] *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).*

[19] *Total climate finance targeting small-scale agriculture is close to USD 10 billion. It represents 1.7% of the total climate finance tracked covering only a small fraction of the general needs of small-scale agriculture actors. https://www.climatepolicyinitiative.org/publication/climate-finance-small-scale-agriculture/*

- **Support and invest in traditional crops and production systems which are relatively resilient to climatic variations**, including root crops, breadfruit and selected timber species. Such support should acknowledge the contribution that traditional crops, such as breadfruit and sweet potato, can make in reducing the impact of NCDs — a win-win situation.
- **Provide financial support** — subsidies, incentives, loans and revolving funds can all provide pathways for the growth of FOs.

Governments, specifically, can provide support for FOs by providing:

- **Enabling policy, regulatory and legal frameworks for FO operation.** The performance of FOs can be undermined by inadequate policies and disabling regulatory environments (Shiferaw et al. 2008). In contrast policy measures can be used to encourage FO membership. The study by Ma et al. (2023) outlines how policies can be designed to support FOs. Frameworks should aim to enhance service delivery and strengthen the impact of FOs.
- **Access to credit and extension services to enable more widespread and effective engagement of farmers in FOs.** Bizikova et al., (2020) carried out a scoping review of the contributions of FOs to smallholder agriculture. Some of the reviewed studies emphasized the need for direct government support for FOs through access to credit and support for market access. For example, simplifying a registration process would facilitate the smooth formation and operation of a group in situations where formal registration is required to access inputs and services.
- **Investment in capacity building for FOs.** Specialized training, for example, in technical and marketing skills, could strengthen FOs, contributing to their success and importantly, sustainability.

Development partners can support FOs by:

- **Negotiating innovative public-private-producer partnerships** that bring FOs and private sector operators together to ensure that public-private collaborations benefit small producers.
- **Investing in creative and innovative networking tools and mechanisms that support FOs,** for example, in knowledge exchange, where the use of digital platforms can mobilize and connect farmers.
- **Supporting the institutional development of FOs,** including the development of organisational, strategic and financial tools/plans.
- **Supporting the systematic participation of FOs** in formulating country strategies and designing projects.

4.2 Farmer Organisations

What can FOs do to ensure support for their role in building farmers' adaptive capacity and strengthening the resilience of Pacific food systems?

- **Increase visibility** - improve awareness of the benefits and advantages that governments and development partners gain in working with FOs, in particular decentralised research with its focus on the local context. Well-established communication strategies help increase visibility and strengthen messages.
- **Ensure that farmer-focussed research priorities are known to governments, development partners and private sector.** FOs should endeavour to be represented on the boards and committees of agriculture-focussed institutions and agencies so that the interests and priorities of farmers can be considered when making research decisions.
- **Seek out and nurture partnerships with public research organisations and the private sector** to undertake the necessary research.
- **Promote the relative climate resilience of traditional crops and farming systems** and stress how a focus on traditional crops and farming systems can contribute to alleviating the increasing incidence of NCDs.
- **Strengthen the coordination/linkages between policy, research and practice** so policies better build on local experiential knowledge and develop partnerships and networks with other stakeholders to strengthen role in influencing policy.
- **Assess ways in which farmers can be supported to:** (a) improve decision-making under uncertainty; (b) be proactive; and (c) respond to continuously changing weather patterns.
- **Aim to better quantify the impact of FOs including the scope and extent of the transformation**[20] — encouraging the use and adoption of sustainable/climate-smart practices does not necessarily lead to a full-blown transformation.
- **Strengthen understanding of how to encourage farmers' capacity in forward planning** — especially important considering the uncertainty of predicting how particular crops and cropping systems will respond to different climate variables and of projecting future climate for specific locations on individual islands.
- **Strengthen understanding of the limits to adaptation, and develop ways in which adaptation limits can be identified,** that is, where adaptation limits are likely to occur and who is most likely to be affected. Such an approach can help to better plan for climate impacts.

[20] *While adaptation entails preserving existing structures and ways of being, transformation is often associated with large-scale, profound and deep-rooted changes. For example, this could changes in where farms are located and the types of crops that they grow (https://www.lse.ac.uk/granthaminstitute/explainers/what-is-the-difference-between-climate-change-adaptation-and-resilience/)*

Annex 1: A summary of the observed and projected impact of climate change and climate variability on Pacific Island crops[21].

Crop	Climate change/ climate variability impact in recent decades	Projected climate impact to 2030[22]	Projected climate impact to 2050[23]
Sweet potato	ENSO-induced droughts have had a major impact on production, particularly in PNG	Impact in countries where temperature is currently around 32˚C but sweet potato biodiversity (in particular orange-fleshed varieties) includes significant heat tolerance[24]. As tuber yield impacted by high rainfall, a significant rainfall increase will challenge farmers	Significant impact in countries where temperature is currently about 32˚C but heat tolerant varieties exist. Increasing vulnerability to high rainfall. Impact on pests and diseases unclear – drought is likely to increase problems with weevil and begomovirus
Cassava	No clearly discernible direct impact	Expected to be minimal; possibility of problems with waterlogging and susceptibility to high winds (>30 knots). Possible yield benefits from eCO2	Impact from waterlogging and susceptibility to high winds. Future climate pest and disease interactions likely to be challenging[25]. Possible yield benefits from eCO2
Taro	ENSO-induced droughts and cyclones adversely impacted production. Likely connection between incidence of Taro Leaf Blight (TLB) in Samoa and increasing minimum night-time temperature	Overall wetter conditions could expand areas suitable for taro production. Increased drought periods will pose a threat. Cyclone damage with increased intensity. Likelihood of TLB spreading to countries where disease is currently absent. Increasing rainfall would increase incidence and spread of other pests and diseases. Possible yield benefits from eCO2	Continued spread and increase of TLB and other taro pests and diseases expected. Impact on virus vectors unclear. Cyclone damage with increased intensity. Very high temperature increases (>2˚C) could affect production. Increased drought periods will pose a threat. Possible yield benefits from eCO2

21 *McGregor A, Taylor M, Bourke RM, Lebot V. 2016a. Vulnerability of staple food crops to climate change. In Taylor M, McGregor A and Dawson B, eds. Vulnerability of Pacific Agriculture and Forestry to Climate Change. Noumea: Secretariat of the Pacific Community.*

22 *Temperature rise of +0.5˚ to 1˚C regardless of emissions scenario*

23 *Temperature rise will vary from +0.5 to 1˚C (RCP2.6) to +1˚ to 2˚C (RCP8.5).*

24 *https://cipotato.org/blog/study-finds-untapped-climate-resilience-sweetpotato/*

25 *https://foodtank.com/news/2020/05/impact-of-climate-c hange-on-pests-and-diseases-of-cassava-crop/*

Crop	Climate change/ climate variability impact in recent decades	Projected climate impact to 2030[22]	Projected climate impact to 2050[23]
Cocoyam	No clearly discernible direct impact.	Expected to be minimal. Less susceptible to high winds than taro. More tolerant of drought than other aroids, and is also more resistant to pests and diseases[26].	No direct impact predicted, although future climate pest and disease interactions are unknown. Very high temperature increases (>2°C) could affect production.
Swamp taro	Swamp taro pits found on atolls affected by saltwater intrusion.	Continued loss to sea level rise expected. A further rise of 50—150 mm in sea level is likely to result in further loss of swamp taro production on many atolls by 2030[27] Droughts will exacerbate salinity problems	Could disappear from atoll environments
Giant taro	No clearly discernible direct impact.	Expected to be minimal	No direct impact predicted, although future climate pest and disease interactions unknown. Could be affected by more intense cyclones. Very high temperature increases (>2°C) could affect production
Yams	Impact from ENSO induced droughts and cyclones. No clearly discernible direct impact on wild yams	Domesticated yam production more severely impacted by cyclones. No impact on wild yams expected[28]. Increased rainfall will worsen problems with anthracnose	Projected temperature rise could affect tuber bulking. Domesticated yam production increasingly affected by cyclones and wetter conditions (anthracnose). No impact on wild yams expected. Pest and disease interactions unknown

26 *https://onlinelibrary.wiley.com/doi/10.1002/9781119180661.ch15*
27 *Bourke, RM, 2018.*
28 *https://www.theguardian.com/society/2021/dec/19/how-bringing-back-the-wild-yam-is-feeding-the-hungry-in-drought-hit-madagascar*

Crop	Climate change/ climate variability impact in recent decades	Projected climate impact to 2030[22]	Projected climate impact to 2050[23]
Rice	High night temperature is a major constraint to sustaining global rice production under future climate[29]. Extreme rainfall has reduced China's rice yields by 8% over the past two decades[30].	Continued increase in temperature can result in decreased global production of rice. Rainfall volume directly impacts rice output - rice production is highly susceptible to flooding and drought events caused by climate variabilities[31].	Severe global shortages likely in rice available for export. The high price of imported rice expected to enhance the comparative advantage of Pacific Island rice production and other staple food crops
Breadfruit	Apparent changes in fruiting patterns due to changes in rainfall	Expected to be minimal though cyclone damage likely to increase though higher temperatures could reduce fruiting and fruit quality.	Expected to be minimal but certain level of reduced quality of yields in the future[32]. Cyclone damage will worsen with increased intensity of cyclones. Possible increase in pest and disease problems
Aibika	No apparent impact from any change	Minimal impact likely from increasing temperature, but extremes of rainfall will increase pest and disease problems. Increase in frequency and intensity of drought will affect growth	More problems with pests and diseases because of extremes of rainfall
Bananas	Cultivation at higher altitudes with warmer temperatures. For 27 countries–accounting for 86% of global dessert banana production - annual yields have increased by an average of 1.37 t ha-1 since 1961[33].	Favour cultivation in currently sub-optimal locations and at higher altitudes. Higher temperatures could affect flowering and fruit filling. Higher temperatures could increase nematode and weevil damage, and possibly BBTV. Higher rainfall could increase BLSD and Fusarium wilt. Increase in cyclone damage	Overall yields likely to decline. Drought stress is an important limitation to yield[34]. Increased pest and disease pressure (Fusarium wilt, nematode and weevil). Rainfall impact on BLDS could be lessened by higher temperature. Heat stress effect on flowering and fruit filling. Increase in cyclone damage

29 *Bahuguna et al. 2017*
30 *Fu et al. 2023*
31 *Joseph et al. 2023*
32 *Yang et al. 2022*
33 *Varma and Bebber, 2019.*
34 *Abdoussalami et al., 2023*

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