


What can the experiences of rural women in Solomon Islands teach us about innovation in aquatic food systems?

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Abstract: *In Solomon Islands, women's groups play an important role in promoting socially inclusive development and women's empowerment. In this paper, we summarise the experiences of a 5-year participatory action research partnership to enhance rural livelihood activities based on aquatic foods. The women's savings groups that participated in this research identified solar-powered freezers as an innovation suitable to their skills and environment. The 12 freezers we used in our partnership to pilot this innovation had tangible benefits. More than 700 unique users accessed the freezers, 3900 kg of fish was stored and over USD6,000 was saved in total; however, accumulation of savings varied greatly between groups. The women's groups demonstrated that operating solar-powered freezers can be financially viable, and the innovation integrated well with their livelihood activities. This conclusion provides an alternative to dominant development narratives, which tend to focus on building large-scale infrastructure, and often exclude women. Existing marketing skills and cooperation were strengths on which the women built. Poor-quality technology was the biggest impediment to success. Solving this basic problem should be a priority for any future cold-storage initiative.*

Keywords: *participatory action research, research partnerships, rural development, solar-powered freezers, women's collectives*

Introduction

Women in Solomon Islands occupy key roles in fishing, both in production and in post-harvest-related activities (Vunisea, 2008; Kruijssen *et al.*, 2013; Gomese *et al.*, 2020). Foods from the ocean are caught or collected, then distributed through purchase, gifting or bartering (Ross, 1978), with women being the main actors in the trade of fish in rural areas. These practices generate benefits both in the form of livelihoods for the people involved and food and nutrition security of island populations (Gillett and Cartwright, 2010; Farmery *et al.*, 2020).

For decades, the coastal fisheries sector has been an area of investment based on the awareness that enhancing the livelihoods of people who catch, process or trade with aquatic foods can be a pathway to poverty reduction and food security (Boape, 1999; Gillett *et al.*, 2008; SPC, 2015). However, investments have commonly followed global development blueprints based on the premise that Indigenous systems would benefit from external input to be made more efficient (Ben-Yami and Anderson, 1985; Bailey and Jentoft, 1990; Overå, 2011). Consequently, in many Pacific Island countries, national fisheries agencies' budgets and

international aid are directed towards the construction of infrastructure to concentrate small-scale fishers and arrange cold chains, but where costs often seem to outweigh benefits (Boape, 1999; Chapman, 2004; Gillett, 2010). Despite these widespread investments and planning, rural women in Solomon Islands still report that their fish-based livelihood practices are ignored (Ride et al., 2020).

A key message from the seminal literature on rural development and livelihoods from the 1980s and 1990s was to “identify what the poor have, rather than what they do not have ... and build on their strengths” (Moser, 1998). This message resonates with lessons from the Pacific where efforts to enhance and diversify livelihoods that are not attuned to community capacity, needs, aspirations and opportunities are unlikely to survive project lifetimes (O’Garra, 2007; Govan, 2011). Listening to the ideas of the people who catch, process and trade fish, and engaging in processes of social change that are already underway in an area, can provide an alternative to dominant development narratives. It is also an area where practice and research can interface through participatory action research (PAR) to address the long-standing challenge that research participants, and studied systems generally, experience the least benefit from research (Chambers, 1983).

Studies have highlighted how novel technologies can intersect with social innovation and be impactful for women (McKinnon et al., 2016; Fröcklin et al., 2018; Brugère et al., 2020). In this study, we summarise 5 years of learning together in a research-in-development partnership between WorldFish and the West ‘Are’Are Rokotanikeni Association (WARA), a rural women’s association in Solomon Islands. Planning for this research was guided by national women’s leaders in Solomon Islands and based on the belief that embedding external support activities within local processes can be a credible change pathway to advance collective goals (Pollard, 2003; SPC, 2020; Suti et al., 2020). The partnership described here focuses on local ideas for enhancing women’s fish-based livelihoods.

WARA: A leading women’s group in Solomon Islands

In Melanesia, women’s groups play a transformational role in promoting socially inclusive

development and women’s empowerment through voluntarism and self-financing (Pollard, 2003; Scheyvens, 2003; Olowu, 2007; Cox, 2017). WARA was founded in 1999. By 2018, it included more than 1000 members – approximately 50% of the total female population in West ‘Are’Are. The group is an Indigenous women-led organisation that develops skills in business and operates as a set of saving clubs. The association has been a model for other women’s groups in Solomon Islands. At its peak, WARA reached a collective savings balance of SBD2 million (USD250,000). However, this dropped during 2020–2021 due to increased savings withdrawals caused by COVID-19 situation, which had created local economic stresses, including low copra price, halted logging activities and reduced cash flow in villages (Eriksson et al., 2020a). WARA’s work is divided into 12 zones in West ‘Are’Are. It operates in a region that has no access to commercial banks or market infrastructure. The association now has seven employees and three volunteers at the central office.

West ‘Are’Are is located in the south-west of Malaita island and is approximately 3-hour ride by motorised boat from the provincial capital, Auki (Fig. 1). There is no road infrastructure within this part of the island and the main modes of transportation are limited to walking, irregular shipping and canoes. Electricity is confined to some solar-powered chargers. Most people survive by subsistence farming with yam, sweet potato and taro as the most important crops. It was within this context that we began to explore what livelihood projects the women had experienced before in their villages, and which of those had remained most useful for them over time – seeking an entry point for a research-in-development partnership.

Sharing experiences about development and diagnosing a new idea

Agricultural and innovation systems programmes are commonly guided by Chambers’ (1983) wisdom to “reverse” thinking in development and research (Apgar and Douthwaite, 2013; Douthwaite et al., 2015; van der Ploeg et al., 2016). Our collaboration was formed around participatory approaches to rural appraisal and action research, building on a long tradition of practice



Figure 1. Map of southern Malaita, Solomon Islands, with West 'Are'Are along the west coast of the region [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/apa.12383)]

seeking to respond to, and feed back into, participants' prioritised development activities (Chambers, 1997; Greenwood and Levin, 1998). In 2016, a collaboration began that sought to build on the capacity for generating and using knowledge among WARA members by recognising their existing skills and prioritised ideas. The role of WorldFish was to support emerging processes that may only be part of a longer journey of local development and change (see analogous example in Sukulu *et al.*, 2016; Teioli *et al.*, 2018). The activities built on the learnings from implementing a multidisciplinary research-in-development approach under the CGIAR Research Programme on Aquatic Agricultural Systems (Douthwaite *et al.*, 2015), which was completed in 2015. This approach reflects an integrated process of knowledge co-production and places emphasis on participation, partnerships and coalitions. Workshop events and discussions with the community groups of WARA were arranged in 2016 and 2017 to facilitate a participatory rural appraisal diagnosis process with the view of it leading to a sustained PAR process, which we present here.

Workshop activities started by discussing external projects, and how they differ in their

approaches and objectives (Fig. 2a). The many experiences from projects at the intersection of conservation and sustainable development in Solomon Islands point to frequent mistrust and emphasis on “cargo” rather than self-reliance (Foale, 2001; Govan, 2011), which has fostered aid dependency and clientelism, or what is locally sometimes labelled as a “hand-out mentality” (Cox, 2009). With these early workshop activities, we sought to facilitate discussions about how a project could enable WARA to meet their real needs relating to fish-based livelihoods, rather than pitching preconceived ideas or external priorities (see Schumacher (1973) and Max-Neef (1983) for this philosophical point of departure).

The collective had experienced many projects in the past; at least 50 different externally supported initiatives were listed. Most commonly, projects had focused on infrastructure and materials, such as water tanks, solar panels and building materials. Some projects had also sought to build technical capacity and expertise. Projects that “worked” in the eyes of the women were trainings, solar-powered lights, water tanks, school construction, farming



Figure 2. Pictures illustrating the journey of: discussing previous projects (a); diagnosing the solar-powered freezer idea (b) installing and learning to use the equipment (c,d); and carrying out research around enterprise practices, including setting price lists (e), identifying hygienic storage practices (f) and developing a protocol with targets and logbook to track savings and goods stored (g) [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/apv.12883)]

materials and seeds, poultry materials and market construction; that is, humanitarian “one-off” deliveries and initiatives appropriate to local capabilities and livelihoods. Things that did not last were cattle and fisheries centres, and coconut crushing mills – overly ambitious initiatives that require continuous external input, rely on new forms of governance, and do not align with existing livelihood activities and knowledge. So, we made this broad conclusion together: a project’s success relies on how well it aligns with the way people live their lives.

These discussions transitioned to how the women earn money for their savings club. When discussing how these livelihood activities could be made more efficient or generate more income, lack of access to marketplaces and lack of storage facilities for fish were highlighted as the main constraints. The conversations around infrastructure, transportation and intermittent access to markets/consumers led to some participants highlighting that planning the use of fish was difficult: ‘When the ship does not come, the fish will waste, and we will feed it to the pigs’. It also highlighted that making some products to sell, such as fishcakes, is reliant on access to fish at the right time. For example, some women would sell fishcakes to school children in the morning, but this is problematic if fishers return with catch a bit later in the day.

Through this process of identifying such barriers or difficulties, some participants suggested the need to preserve fish. This would prevent waste and help make activities possible or more efficient and increase options for making additional income. This was particularly noted as women expressed time constraints on their daily practices (e.g. household responsibilities and agricultural work). The group therefore suggested testing solar-powered freezers, which they had seen in other places. The group discussed this idea and decided that it was something they thought could both help them with existing practices and that renting out freezer space could also be an enterprise on its own. Cold storage could be available in the village for the first time, which would enable marketing and new forms of economic activities for the groups at their own pace and scale. Once some of the participants had thought of the freezers and started talking about them, many others also became vocal and interested in the idea.

In a subsequent meeting, the idea to test solar-powered freezers was assessed using a structured livelihood diagnosis tool organised around six themes (Govan *et al.*, 2019). Breakout groups diagnosed the idea around the themes – natural resources, equipment, people and skills, markets, finances and

information – guided by the prompts in the diagnosis tool and WorldFish team members (Fig. 2b). Each small group concentrated on one theme. For example, one group discussed pros and cons relating to natural resources, while the next did the same for people and skills, and so on. After carrying out their assessments, each group reported back to the full group in a plenary session that summarised the assessment in a matrix for oversight of the pros and cons. For five of the six themes there were no notable barriers to adopting freezers. However, the equipment component – how to service freezers if they break – was quite unclear. Overall, the assessment generated a positive view of the idea.

A total of 12 solar-powered freezers, one per rural WARA zone, were consequently acquired using project funds and installed by a technician from the supplier in Honiara, enabling the collective to operate cold-storage enterprises based on their diagnosis (Fig. 2c,d). The freezers were installed in batches from 2017 to 2019 to incorporate learning from pilots into later enterprises, such as setting price lists and hygienic practices for storing foods (Fig. 2e,f). Each zone established a committee that planned and organised the operation of the enterprise, including the location of its freezer, responsibilities over daily operation and record keeping, and how to spend the money earned from the activity. In order to gauge financial sustainability of the initiative, a conservative savings target was set based on known costs and expected lifetimes of materials provided by the supplier of the freezers (Table 1). Based on this, a protocol was developed with targets and logbooks that were filled in by freezer committee members to track savings and goods stored (Fig. 2g).

Although the groups were able to draw on their experience in operating as a collective and quickly set up economic activities around cold storage, their enterprises were marred by the unreliability and technical flaws of the freezers. The first three pilot set of freezers operated well, but the subsequent freezers were unreliable, with faulty parts halting operations. Six freezer committees experienced difficulties early on, followed by another two later. Much of the ensuing planning and monitoring consequently focused on solving intermittent technical problems and shifted emphasis of the programme of work towards managing the servicing of freezers

Table 1. Savings target for each solar freezer enterprise calculated in consultation with suppliers of the freezer kits indicating an assumed 5-year battery life and 10-year freezer-kit life

Costs and targets	Amount (SBD)
Total cost of solar-powered freezer set, assumed life span of 10 years	21 900
200 Amp battery, to be replaced after 5 years	3900
<i>Total cost to be recovered over 10 years</i>	<i>25 800</i>
Yearly target (SBD25,800/10 years)	2580
Monthly target (SBD2,580/12 months)	215

Note: Italic indicates symbolise a summary of the two preceding rows.

through the supplier in Honiara, a significant issue in the remote and inaccessible parts of Malaita. During 2020, faulty parts were replaced in the freezers and operations could resume in a more reliable way and at a better pace.

Materials and methods

We evaluate this initiative in two parts. First, we gauge the performance and utilisation of the solar-powered freezer enterprises. The data source for this part of the study ('Freezer enterprises and use' section) is the logbooks kept at the 12 rural freezer enterprises. Second, we want to understand what the views of rural women who participated in the activities can teach us about rural fish-based livelihood projects. We use the narratives from 18 women involved in the initiative as the data source for this part ('Views of rural women' section).

Freezer enterprises and use

A basic logbook was designed with the WARA groups to ensure a simple and logical way of keeping records over transactions and goods stored (Supporting Information 1). Each group was trained to use the logbook, and the lead author (MB) regularly called group members that were recording entries to monitor how freezer enterprises were going. Data from logbooks were collected regularly during follow-up trips twice a year to meet and discuss any problems faced during the implementation phase. The data from logbooks helped monitor the

enterprises through time. Data were entered by committee members in ways that worked for them – usually by a designated bookkeeper, sometimes living adjacent to the freezer location in the village. All data were summarised in April 2021 in relation to total earnings, patterns around the goods stored and frequency of freezer use by unique customers.

Views of rural women

We recorded the experiences of women as members of WARA and the freezer committees. This method was inspired by the life-history method of Lewis-Beck *et al.* (2003). From these personal stories, we described the problems with, and opportunities for, enhancing fish-based livelihoods. In each zone, verbal consent to conduct the interviews was sought, first from the zone president and then from individual respondents. Most women speak 'Are'Are in their homes, but Pidgin was used during the interviews. Pidgin is the lingua franca in Solomon Islands.

In all, 18 women from 9 WARA zones were interviewed during 2019. Women selected for interviews were members of a freezer committee. The interviews were conducted by the lead author (MB) using a topic sheet to help guide conversations (Supporting Information 2). We recognise that our own team member carrying out the interviews may have introduced bias in the way conversations were constructed and how messages were given by respondents. On the other hand, the interviews were possible because of the strong sense of trust and mutual respect built up over 4 years of collaborative relationship-building.

Some women were interviewed at night as they had many commitments during the day. Data entry was done straight after each interview before moving to other sites. All the stories were entered in a NVivo (qualitative data analysis software) database and coded for themes, including what livelihood activities women did, the role of other household members, where women did their livelihood activities, how they use the income, and challenges and changes that had happened in their lives in regard to their livelihoods.

Ethics and principles of engagement

The research was carried out with ethics permission from the University of Wollongong (2017/565). The research practices are embodied in the “principles of engagement” in the WorldFish Solomon Islands programme: transparency, predictability and accountability (Schwarz *et al.*, 2021; Eriksson *et al.*, 2022). Accordingly, the focus of the relationship between WARA and WorldFish was to define points of common interest and co-creation of knowledge. For example, the logbooks were designed with the women's committees and records kept by committee members for the dual purpose of group bookkeeping and monitoring for evaluation.

Results

Freezer enterprises and use

Customers. Across the 12 zones operating solar-powered freezers, there were 711 unique customers, 440 females and 271 males (Fig. 3). There was high variation in use between zones, with the number of customers ranging from 20 to 132, depending on the size of the village. On average, there were 47 new customers per month in the first year of operation, followed by 7 new customers per month, which indicates quick adoption. This rate of adoption did not differ between women and men users. In addition to these individual customers, there were approximately another 60 community groups (e.g. church groups, social groups, schools, clinic) that also used the freezers.

Across the zones, customers stored their goods in the freezers for an average of 2.3 nights. This range indicates different patterns in use, with the average time of storing goods varying between zones (Fig. 4). Note that Zone 8 is urban Honiara, and hence not included in this study. The 12 rural zones are 1–7 and 9–13. The lowest average storage duration was at just under 1.4 nights and the longest duration was 15 nights, which was recorded once each at two different freezers.

Collection of fees. The women's groups operating solar-powered freezers collected a total of SBD50,503 (USD6,212) in fees.

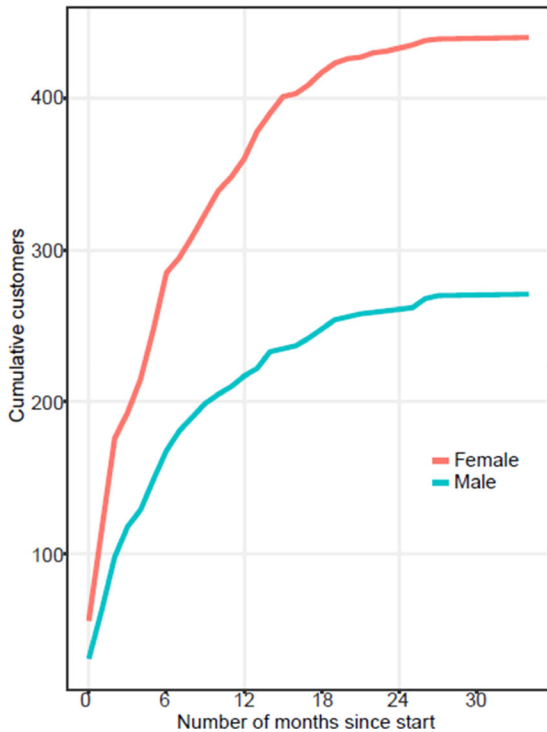


Figure 3. Cumulative curve of the number of solar-powered freezer customers over time, by gender. Logbook records included an additional 50 incomplete names of unique customers that were excluded from the data [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/apv.12883)]

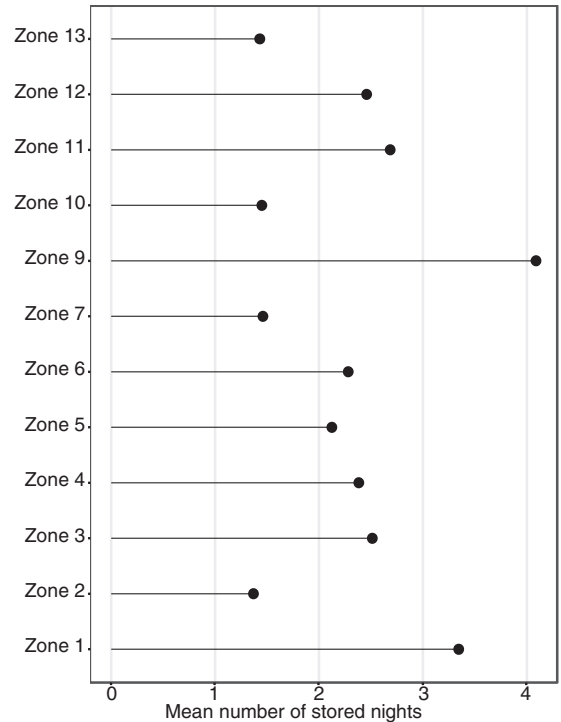


Figure 4. Mean number of nights customers stored their goods in the solar-powered freezers, by zone. (Zone 8 is in urban Honiara, so was excluded from this research.)

The duration of freezer operation varied across zones, as did the rate at which fees were accumulated (Fig. 5). Zones 12 and 1 collected the most in fees, but only operated their freezers for 14 and 15 months, respectively. Zone 9 almost equalled Zone 1 in total fees collected, despite that freezer operating for only 9 months; this zone also had the highest rate of collected fees, SBD637 per month during operation, far above the monthly target of SBD215. The shortest duration of freezer operation was 6 months in Zone 4, but in that time the group collected SBD2,134 in fees (SBD356 per month). Conversely, three zones operated their freezers for more than 30 months, with Zone 3 operating for the longest duration of 36 months.

Within the first 12 months, when most freezers were operating well, eight of the zones saved above their monthly targets. By the end of data collection, five zones had met the monthly target of SBD215, but had to stop their business due to technical problems with the freezers. The other seven zones could not meet

the saving target, due to technical freezer problems, and would therefore not be financially viable.

Most of the storage fees collected were from market-related activities. Of the total storage fees collected, 46% (SBD23,362) were from customers that intended to sell what they were storing in the freezers and 19% (SBD9,800) were from customers using the freezer for fundraising (Fig. 6). In contrast, 13% (SBD6,753) of the storage fees collected were from customers that intended to consume what they were storing, and 21% (SBD10,538) did not specify the purpose.

Types of goods stored. Each zone operating a solar-powered freezer stored a variety of goods (Fig. 7), including different types of aquatic foods such as fish, invertebrates, shells and turtle. A total of 39 000 kg of fish was stored in the freezers, representing 32% of all the goods stored across the zones. This was followed by meat such as chicken and sausage (28% of total goods stored) and ice lollies (20%). Zone 5 had the highest percentage of aquatic foods stored,

at over 60%, while in Zone 11 meat constituted 65% of goods stored. The most frequent type of good stored in Zone 13 was water (49%). Zones 1, 3, 6, 12 and 13 all stored the most diverse types of goods – which spanned all of the categories we disaggregated.

Views of rural women

Stories about livelihoods. Women told stories about the many different livelihood activities they had experienced during their lifetime. Many women told stories about how these activities changed during their life. Eight out of the 18 participants were employed at a certain moment in life, most commonly as teachers in primary schools. Some women mentioned caring for parents or children as the reason for not pursuing paid jobs. Husbands of the women were also typically involved in multiple livelihood activities. Men were often involved in activities that women were not; for example, logging and carpentry.

All women were engaged in selling goods to generate income. The most commonly sold product was cooked food, followed by fresh garden produce. Fish, mangrove clams and mangrove fruits were also often sold. Women's decisions on what to sell depended on access (seasonal crops), marketing opportunities (community events, ships and logging sites) and the availability of cash in the community. Husbands and children often helped in preparing products to sell.

Most women chose several locations to sell their products, including schools, church and school events, logging camps, at ships, or markets in bigger villages like Hauhui, Uhu or Afio (Fig. 1). Rather than marketing at a certain location, women in Kiu and Hauhui walked around their villages to sell their products: so-called 'walkabout markets'. Some women sold products at their own house.

The most common challenge identified by women was the lack of cash flow in the village. When people do not have money, they can take products on credit (*kaon*), promising to pay later. Another problem is that most women sell the same products. One vendor said: 'When a large number of women sell the same product at school, students are unable to buy everything, [whereas] it's easy to sell everything

quickly if I am the only one selling one product at a time'. Another woman vendor said: 'It would be best if vendors sell varieties of products to avoid competition. No cash flow makes it even harder to quickly sell out goods'.

Women were asked who makes the decisions on household spending. The majority said they made these decisions themselves. Three women had no men in the house so by default they made their own decisions. Most women reported that they used their income to take care of household and children's needs, savings and church contributions.

As one woman said: 'Income earned from marketing is always sub-divided for household needs, church activities, and savings both for Roko [Rokotanikeni] and WorldVision-saving schemes'. Two women mentioned that they used their money to pay off loans and outstanding debts. Four women said that their husband made the decisions about money and spending.

Stories about solar-powered freezers. The women's groups operated the freezers as micro-enterprises by renting out freezer space to customers, and by storing and selling products. The money earned from the freezers was kept and managed by the committees. Some committees used the money for maintenance purposes, some used part of the money for their revolving funds, while others were yet to decide what they would do with the money that they earned.

In general, the women were satisfied with the freezers because it helped in their income earning activities. This was also indicated by requests for more freezers from the committees. Many women mentioned WARA helped them form friendships and cooperate. The women interviewed said their income had increased through use of the freezer, particularly through selling high-value products like meat and fish. The solar-powered freezer micro-enterprises seem to have further increased support for WARA in the communities.

The women also reported a few challenges with the freezers. The most common problem was freezer unreliability, which cast doubt on the project in some places. Another issue frequently mentioned by women was hygiene. One woman who looks after one of the freezers said: 'The main challenge is when fishermen

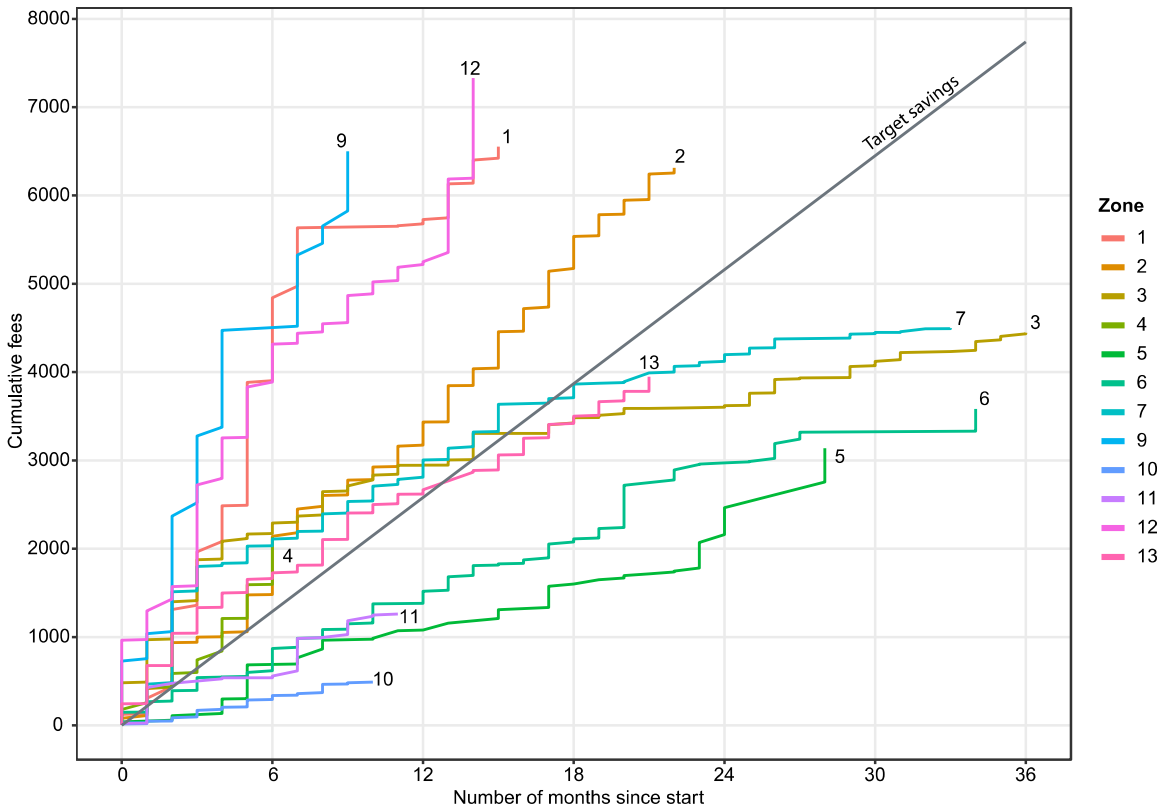


Figure 5. Cumulative fees collected for each zone across time. Cumulative curves stop where that zone’s solar-powered freezer stopped operating, or where data collection ended. (Zone 8 is in urban Honiara, so was excluded from this research.) [Colour figure can be viewed at wileyonlinelibrary.com]

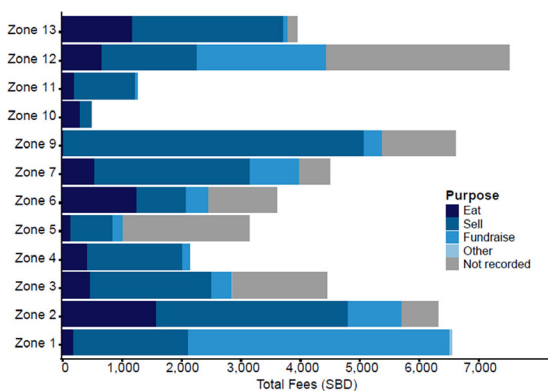


Figure 6. Total fees collected in each zone, by the customer’s intended purpose. The category ‘other’ relates to fees collected for mobile phone charging and storing fishing bait. (Zone 8 is in urban Honiara, so was excluded from this research.) [Colour figure can be viewed at wileyonlinelibrary.com]

blood which when it drips into the freezer, creates a bad smell. Sometimes I ask the fishermen to properly clean their catch before I could store them in the freezer. I also explain to customers that unclean fish will produce a bad smell causing fish to rot and contaminate everything in the freezer’.

Stories about WARA. It is important to note that these women’s groups had been working together for several years. Many women had participated in trainings organised by WARA on topics ranging from financial literacy and business development, to community leadership, gender-based violence and organic farming. Women said that they gained new skills like sewing and dyeing of clothes, weaving of baskets and hats, gardening, cooking and baking, and public speaking. Sixteen out of the 18 women mentioned that the training on financial savings provided by WARA was a key change in their lives. Women reported they

want to store their fish in the freezer without properly cleaning the fish, especially bonito. It’s challenging because this fish contains a lot of

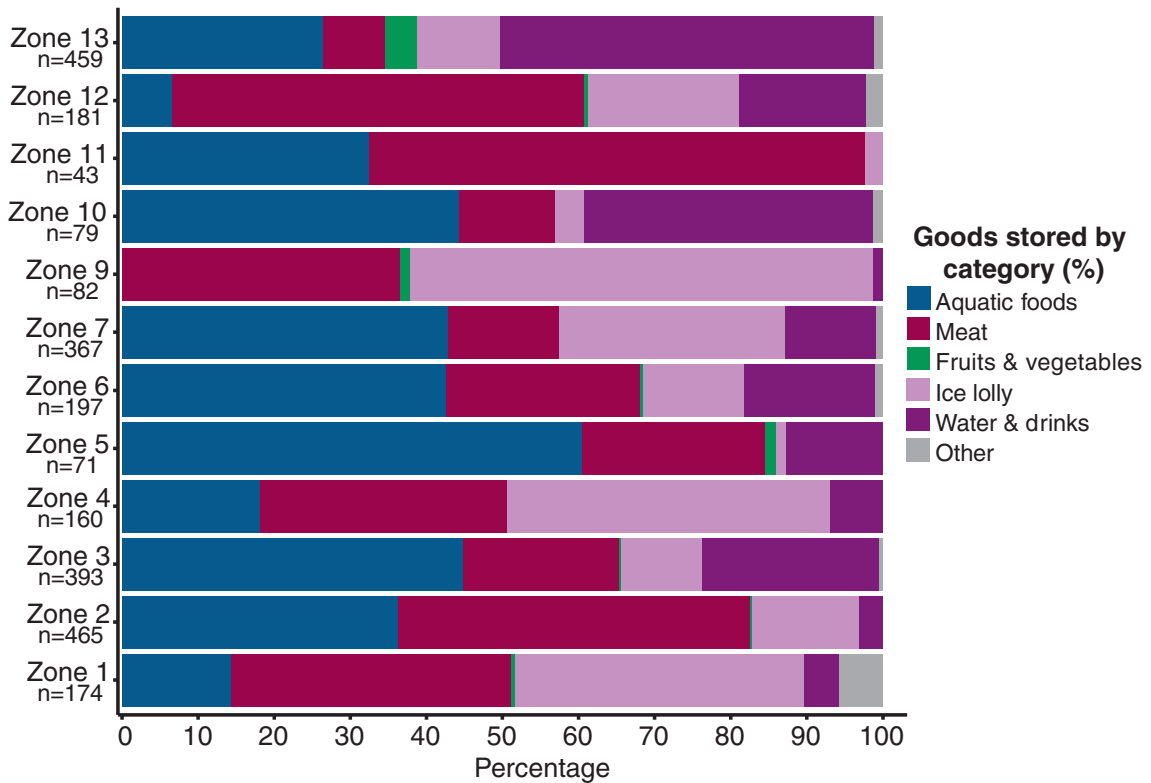


Figure 7. Percentages of logbook entries that reported storing different categories of goods, by zone (where n = number of entries in logbooks). The category “other” relates to processed food such as ice cream and cake, as well as mobile phone charging. (Zone 8 is in urban Honiara, so was excluded from this research.) [Colour figure can be viewed at [wileyonlinelibrary.com](https://onlinelibrary.wiley.com/doi/10.1111/apv.12383)]

save money for times of need, marriages, school fees, solar lighting, household items and health services.

Seventeen out of the 18 participants said that attitudes of people in the community towards WARA had changed over the years, as people started to see benefits from WARA activities. One woman said: ‘Now men started to support Roko compared to the past when they say we worked hard for nothing or our woman founder just lied to us. Despite these comments we said nothing, but recently we noticed that men started to help and support us’. Another woman said: ‘Some men started to support Roko when their wives joined the association and became leaders. This change started two years ago and with new livelihood ideas like the solar freezer, no negative comments were heard, but men continue to support our work’. WARA women are also increasingly represented in the village governance committees.

Despite these positive remarks, 16 out of the 18 women said that other women sometimes talked negatively about WARA. Women said that non-WARA members were sometimes jealous of the success of WARA women, and spread rumours and misconceptions about WARA. For example, one woman said that WARA built a market house to sell their products in their village, but non-WARA women discouraged people from buying here.

The national elections in 2019 caused conflict in the community between different people supporting different candidates. This also affected WARA in some communities where the organisation became split between the different groups of supporters. One woman said: ‘Politics is another issue that causes friction within Roko, our church, and even our community. It also spoils us and I don’t know who will bring back women’s thoughts together again. This recent election is the worst in [our] village, it causes

brothers to fight each other and even leads to a husband being separated from his wife’.

Recently, international organisation World Vision has created savings clubs in the same areas where WARA operates, which has divided efforts and created conflicts between some women aligned to the different programmes. Some of the women complained that the interest of women was high when there was some sort of material assistance (like solar lighting or solar-powered freezers) but membership and interest in the activity would wane afterwards. One WARA committee member said: ‘Some women are eager to join Roko when it receives assistance from the outside like the solar freezers. These new things pull women’s interest to join and this attitude was experienced with the solar lighting, sourced by Roko in the past; however, after they received such assistance, they withdrew their membership and left Roko’.

Discussion

The spoilage of perishable food in complex environments is a problem occurring in many contexts and food systems around the world. In Solomon Islands, the transportation and distribution of highly perishable fresh foods from the garden or sea to the urban marketplace are difficult and expensive. Broad observations about the structural challenges with fish distribution have highlighted a range of issues, including a lack of hygienic fish handling and processing, limited transport opportunities, limitations in processing and storage options, and barriers to market access (Kruijssen *et al.*, 2013; Mauli *et al.*, 2023). This a driving factor in the influx and acceptance of refined foods like rice and flour or long shelf-life convenience foods, all of which paradoxically tend to outcompete domestically grown crops and fish in price, access and availability in urban settings (Coyne *et al.*, 2000). The modern Pacific food system has generated malnutrition and poor health outcomes, prompting the need to explore transitions focusing on local innovations and aquatic foods (Andrew *et al.*, 2022). Thinking about people’s real-life experiences and abilities is critical for design of services that can support such locally led innovation. We discuss our

experiences and learning in this PAR under three themes: social innovation, novel technology and alternative development thinking.

Social innovation

Engagement with existing collectives, such as vendors and fishers associations, women’s savings clubs or church groups, can support endogenous development processes (Roche *et al.*, 2020; SPC, 2020; Suti *et al.*, 2020; Eriksson *et al.*, 2020b), particularly where women are leading the initiative (Cox, 2017; Fidali and Larder, 2022). Building on existing strengths and organisation in WARA, and organising activities in support of its goals, was an important feature of the PAR process.

Marketing is a principal activity of women in Melanesia (Keen and Ride, 2018), and the freezer enterprises integrated with these practices and experiences of the women’s groups. The stories told in our study illustrate the varied and daily practices of marketing among women in Malaita. They produce, barter, add value and sell through a range of marketing activities, practices that regularly involve many family members. Commonly, marketing activities involve cooking foods for sale at schools, sporting events, village markets or ‘walkabout marketing’. Notably, most of this marketing happens ‘below the surface’ of the formal economy at places far away from formal markets (see Carnegie *et al.*, 2012 for a metaphorical framework of above- and below-surface economic activities). The women involved in this initiative very rarely sold their produce at Auki market. This formal marketplace is often prioritised for development planning in the province (UN Women, 2021), but remains inaccessible for most people in the province. The freezers allowed for new ways of marketing of which the women’s groups took advantage; for example, the buying of frozen meat from Honiara that was stored and sold in the village.

In some places, the solar-powered freezer micro-enterprises appear to have increased respect for women’s groups, as indicated by leaders publicly acknowledging the role of women and these benefits. This experience of supportive leadership at the local level can also strengthen capacity of the community more broadly to organise and meet collective needs.

The way that the freezers were operated shows these women are experienced entrepreneurs. These skills cannot be taken for granted as wide-reaching for all women in Solomon Islands, or the Pacific more broadly (Mangubhai and Lawless, 2021). WARA has a decade-long history of organising training programmes on public speaking, financial literacy, bookkeeping skills and other topics. This potentially leads to better outcomes than elsewhere.

Novel technology

Access to electricity is now viewed as an essential human service, although for most of Malaita's population, grid-electrification seems far away (World Bank, 2017). In theory, solar-powered freezers could transform the rural food system. However, the poor quality of some of the solar technology available for sale in Solomon Islands, which tends to import cheap, and even counterfeit, products not authorised for sale elsewhere (McDonald, 2003), mean that the benefits of the technology remain limited. Once broken, it is almost impossible to fix the freezers in remote parts of Malaita. The disruptions to operations from technical faults in the freezers clearly impacted negatively on use and savings. Any future programming for use of solar-powered freezers must solve this problem. Had it not been for the technical failures, it is reasonable to expect that more enterprises would have been financially sustainable through time.

Small scale solar home systems, which have been supplying homes with electricity in rural Solomon Islands for a long time, have become embedded in everyday life and social reciprocity structures rather than a “development” enabler, as it is often defined in overseas aid and development programming (Hobbis, 2021). This way of thinking serves as an interesting reflection for the freezer enterprises at the intersection of functionality (cold storage, cost-recovery), group earnings (growing savings) and social reproduction (fundraising and standing of WARA). Our PAR was disrupted by the broken freezers and was not able to make significant progress on such transdisciplinary outcome frameworks. Defining what success looks like based on local values is an important future research agenda (McCarter et al., 2018), which

can help relate novel technologies to locally defined well-being outcomes.

Alternative development thinking

The solar-powered freezer micro-enterprises exemplify alternative ways of thinking about rural development in the aquatic foods sector, where blueprint solutions have proven to be ineffective and economically unsustainable. A recently constructed fisheries centre in one of the villages was an example that was brought up by the women in our diagnosis as a type of investment that had not worked well. The construction of fisheries centres is very common in the Pacific (Preston and Vincent, 1986; Boape, 1999). Often, they are the biggest government expenditure in the sector and take up considerable international aid (Gillett, 2010). In Solomon Islands, some centres have been evaluated as financially unviable (Preston et al., 1998). The small-scale solar-powered freezers offer an alternative to this blueprint model.

The *Future of fisheries: A regional roadmap for sustainable Pacific fisheries* urges national governments and their development partners to replace outdated development activities with community-based approaches (FFA and SPC, 2015). This is not a new request. Roughan (1975), for example, emphasised the village as the heartbeat of the national food system and economy, providing a countervailing narrative to the strong focus on western concepts of modernity and development. Our PAR adds to other examples from the region focusing on cheaper, decentralised and locally led innovation for sustainable change (Cox, 2017; Roche et al., 2020; Suti et al., 2020; Sharp et al., 2022).

Adoption of new practices is higher with prior evidence of success. For instance, in a study of urban and peri-urban young women, the most useful skills intervention suggested by the participants was “look and learn” visits or training with, and by, people who had successfully adopted a new practice, process or livelihood (World Bank, 2019). The Solomon Islands National Agricultural Survey 2017 (SIG, 2019) found that 68% of smallholder farmers access information from peers. These are important mechanisms to consider for spreading knowledge in how technologies work, modelling

enterprise ideas, and fish handling (e.g. hygiene and safety of food storage).

Conclusions

The biggest barrier identified in this PAR on solar-powered freezers was not gender, social relations or the skills of the women. It was, as the women had predicted, poor and difficult-to-service technology. Importantly, improving technology is arguably easier for external agencies and partners to achieve than influencing social relations in rural communities. Not all communities or women's groups will be as well prepared as those in this study to adopt technology and work together to form local freezer enterprises. The initiative also highlighted capacity gaps where access to new information and demonstrations can be helpful, such as in safe and hygienic fish handling regarding fish stored in the freezers. The experiences of the women's groups are important for regional and national development policies and strategies (SPC, 2015; SIG, 2016; World Bank, 2017; MFMR, 2019), which all identify that improving the livelihoods of people who catch, process or trade fish is a critical pathway out of poverty and towards food and nutrition security in the Pacific.

Author contributions

Margaret Batalofo facilitated the participatory action research (PAR) process, conducted the interviews, analysed the data (with support from Anouk Ride and Matthew Roscher) and wrote the manuscript. Alice Aruhe'eta Pollard set up the research partnership and provided guidance during various stages of the PAR process. Meshach Sukulu and Matthew Isihanua provided logistical, institutional and intellectual input. Hampus Eriksson and Jan van der Ploeg designed the research and edited the manuscript. All authors reviewed and edited the manuscript.

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Conflicts of interest

The authors declare no conflicts of interests.

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