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Three-Decades of Research Integration—Transforming to Collaborative Aquatic Food Systems Research Partnerships in the Pacific

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High-quality research to provide sustainable development solutions in aquatic food systems requires a deliberate theory for its application at scale. One frequently defined pathway in theories of change for scaling research innovation is through partnerships. Yet, despite the widespread application of partnership modalities in food-systems research, only a small proportion of published research provides original and high-quality solutions for small-scale producers. Metrics of academic success can incentivize publication regardless of end-user impact. Analogously, partnerships among national and international institutions can also lack impact because of inequity and persistent power imbalances. We describe a long-term research for development partnership between a CGIAR center (WorldFish) and a national government agency (Solomon Islands Ministry of Fisheries and Marine Resources; MFMR). We review the literature produced by, or about, the activities carried out in the name of the partnership over a 35-year period to build a time-line and to identify elements of research power, priorities and capacity by decade. The form and function of the collaboration through time form the basis of our analysis of the journey toward an increasingly equitable partnership: a theorized goal toward greater development outcome at scale in Solomon Islands. The partnership has been strongly influenced by changes in both institutions. The MFMR has undergone a significant increase in operational capacity since the partnership was first conceived in 1986. WorldFish has also undergone change and has navigated tensions between being locally impactful and globally relevant through periods of different research foci. With an increasingly competent and capable ministry, dimensions of power and practice have had to be re-visited to embed CGIAR research on aquatic food systems within national development trajectories. By focusing on a practice seeking more meaningful and respectful partnerships, WorldFish—as an international research partner—continues to evolve to be fit for purpose as a credible and effective research partner. We discuss this journey in the context of system-level change for aquatic food system sustainability and innovation.

Keywords: coastal management, innovation systems, power dynamics, research-development partnerships, scaling, small-scale fisheries

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INTRODUCTION

With only nine annual food-growing cycles remaining before the world evaluates progress toward the Sustainable Development Goals (SDGs), there is mounting recognition that fish and aquatic foods must play a central part in addressing many of the world's urgent challenges, including poverty and malnutrition (Thilsted et al., 2016; Willett et al., 2019; WorldFish, 2020). In large ocean states, like the Pacific Islands nations, fish and other aquatic foods are the backbone of island economies and resilience (Gillett, 2016; Eriksson et al., 2017; Farmery et al., 2020). Regional and national development policies identify improved livelihoods of people who catch, process or trade fish as a critical pathway out of poverty and toward food and nutrition security (e.g., SPC, 2015; SIG, 2016; World Bank, 2017; MFMR, 2019). They also recognize that maintaining seafood's contribution to food and nutrition security for growing urban populations depends on improved access to aquatic foods from rural origins. The means by which these policy goals can be achieved remain a challenge.

The pace and scale of identifying innovative development solutions in rural Pacific aquatic food systems have suffered from at least two previously entrenched influences. Firstly, economically valuable commercial tuna fisheries, which underpin revenue, have long trumped small-scale fisheries in policy attention and resourcing [FFA (Pacific Islands Forum Fisheries Agency) and SPC (Secretariat of the Pacific Community), 2016]. Although long recognized as being central to culture, nutrition, village economies and well-being of Pacific people (Epstein, 1968; Ross, 1978; King and Lambert, 2000), the profile and value of rural small-scale harvesting of fish and other aquatic foods were only recently elevated in regional fisheries declarations; namely, the Vava'u Declaration (Pacific Islands Forum, 2007; see also King et al., 2003); Apia Policy (SPC, 2008); MSG Roadmap (MSG (Melanesian Spearhead Group), 2015); Noumea Strategy (SPC, 2015); and the "Future of Fisheries: A Regional Roadmap for Sustainable Pacific Fisheries 2015," endorsed by Pacific Island Forum Leaders in 2015 and the 48th Forum Leaders meeting in 2016 [FFA (Pacific Islands Forum Fisheries Agency) and SPC (Secretariat of the Pacific Community), 2016]. The centrality of "*coastal/inshore fisheries to nutrition security, food security, sustainable livelihoods and economic growth for current and future generations of Pacific people*" (Pacific Islands Forum, 2007) is now reflected in increased attention being given to coastal fisheries in national fisheries policies [Government of Kiribati, 2013; Government of Vanuatu, 2017; NFA (National Fisheries Authority), 2017; MFMR, 2020].

Secondly, the global colonial and post-colonial rural development emphasis was predominantly on modernizing small-scale fisheries and aquaculture with the view that these systems would benefit from external input to be made more efficient (e.g., Ben-Yami and Anderson, 1985; Bailey and Jentoft, 1990; Overå, 2011). The development narratives in the Pacific followed this paradigm (e.g., Boape, 1999; Chapman, 2004; Gillett, 2010). This led to the so-called "pipeline" approach to agricultural research for development permeating the region, whereby expert-led research generates global public goods followed by investment in dissemination and extension (Stokes, 1997; Sumberg et al., 2003). This view of research as a linear process preceding development application has been criticized as a model because it overlooks the required partnerships, institutions and co-learning necessary for systemic change (Lundvall, 1992; Hall et al., 2004). Seeking alternatives, agricultural systems research programmes have begun to take a systemic view of innovation (Wigboldus et al., 2016), where research is embedded within ongoing processes of development and change [CRP AAS (CGIAR Research Program on Aquatic Agricultural Systems), 2011; Douthwaite et al., 2017]. Given the newly elevated profile of small-scale coastal fisheries in the Pacific, a new era of deliberate planning and investment in resources toward equitable research for development partnerships is pertinent.

Making research count for development outcomes is arguably more important than ever. Yet, within the academic structures from which we anticipate high-quality research about solutions, outputs with academic merit tend to be favored over applied research with smallholders and their families (Price et al., 2020). For example, a recent analysis of 100,000 articles in agricultural and agronomic research found that only 2% of published research reported original and high-quality data about solutions for small-scale producers (Anon, 2020). The interweaved co-production of research and practice is increasingly understood to enable change, but it also relies on partnerships that often span diverse perspectives, values and identities (Glasbergen, 2011; Chambers et al., 2021). For example, models of scaling up innovations from small and local to large and many can be inhibited by inertia within various structures and institutions (Mayne and Stern, 2013; Steenbergen et al., 2021), which, in some cases, are set to compete rather than collaborate, inhibiting theorized impact pathways (Starr and Miers, 2020). So the ability to nurture equitable and effective partnerships underpins assumptions in impact pathways (Stokes, 1997; Price et al., 2020). Process-related factors such as the quality, duration and context of research partnerships are key in ensuring that research is relevant, credible, legitimate and effective (Douthwaite and Hoffecker, 2017; Prain et al., 2020).

The aim of this study is to analyze the elements and contexts of a long-term research for development partnership between a CGIAR research center (WorldFish) and a national government agency (Ministry of Fisheries and Marine Resources; MFMR) in Solomon Islands, using the framing of research–development partnerships for scaling, as described by Prain et al. (2020). The partnership spans over three decades and reflects post-colonial national development trajectories along with the disruptions, changes in priorities, and the societal change that the world has experienced over this time. Our analysis contributes an example to the emergent research topic of evaluating equitable research partnerships for development and its role for co-production for sustainable change (Price et al., 2020; Chambers et al., 2021). We discuss observed changes through the lens of power and capacity over priorities and embedded co-production for impact at scale.

MATERIALS AND METHODS

Context

Solomon Islands is a sovereign nation of Indigenous peoples which gained its independence from British protectorate status in 1978. Its political and social context is shaped by both its colonial history and Indigenous and introduced knowledge systems (Gegeo and Gegeo, 2002). A large ocean state in the Western Pacific Ocean, 75% of the current population of 721,455 are described as rural and predominantly farmers and/or fishers, and 18% of the population live in the capital city of Honiara (SINSO, 2020). Aquatic foods are central to nutritious diets (Albert et al., 2020), complementing root crops, fruits and leafy vegetables in the wider agricultural landscape (Ross, 1978; Farmery et al., 2020).

With one of the youngest Pacific populations—median age 19.8 (2009 census) compared with 22 for the region (Wilson, 2020)—education statistics are unlikely to meet SDG targets, although some gains have been made in access to primary education. The expected years of schooling increased by 4.2 years between 1990 and 2019 (UNDP, 2019); however, only 7% of girls finish secondary education (Wilson, 2020). A chronic lack of employment opportunities [ADB (Asian Development Bank), 2010; Wilson, 2020] has been exacerbated by the COVID-19 pandemic [SICCI (Solomon Islands Chamber of Commerce and Industry), 2021]. Nevertheless, the Solomon Islands Chamber of Commerce and Industry pursues the vision of a vibrant private sector, and graduates from national and international higher education institutions provide an increasing pool of qualified candidates from which to recruit. Employment opportunities for graduates are predominantly constrained to Honiara, where in 2015, 17% of women and 23% of men aged 15–49 described themselves as having attained a level of education higher than secondary school (SINSO, 2015).

The partners

The MFMR is responsible for the management and development of the nation's fisheries and aquatic resources in Solomon Islands fisheries waters. This includes inland, coastal and offshore fisheries, the aquaculture and mariculture of fisheries and aquatic resources, and responsibility for a 1.34 million km^2 exclusive economic zone. The MFMR was established as a standalone ministry in 2006 from a Fisheries Department that had been embedded within other ministries since before independence (Brown, 2016).

There have been several assessments of the capacity of agencies responsible for addressing the needs of rural people who depend on small-scale fisheries. Almost without exception, and as late as 2014, these analyses lamented the lack of capacity in staffing levels, expertise and funding (Wilson, 2008) in both the private and public sectors (Lane, 2006; World Bank, 2007, 2012; Sulu et al., 2014), and note the lack of access by fishers and communities to advice and information (Hunnam et al., 2001; Lane, 2006). By 2013, inshore fisheries sector policy was starting to be developed (Govan et al., 2013). Subsequently, effective partnerships with provincial governments and civil society partners were identified as one vehicle to overcome some of the capacity constraints faced in facilitating conservation, management and development of inshore and inland fisheries (Thomas et al., 2016; MFMR, 2019).

The CGIAR center WorldFish (previously ICLARM—the International Center for Living Aquatic Resources Management) is an international, non-profit research organization that harnesses the potential of fisheries and aquaculture to reduce hunger and poverty. WorldFish currently implements the CGIAR Research Program on Fish Agri-Food Systems—interconnected and interdependent systems comprising fish production, processing, marketing and consumption. The high reliance on fish for incomes and nutrition in Solomon Islands positions WorldFish as a relevant research-in-development actor supporting the MFMR and Provincial Governments.

In 1986, ICLARM was invited by the Solomon Islands Government (SIG) to establish a long-term regional aquaculture research facility, on the basis of a formal 50-year hosting agreement between the institutions. The ICLARM Coastal Aquaculture Centre was built on land near Honiara allocated by the SIG. Among other obligations, ICLARM would supply the SIG with information on research carried out at the center and furnish technical advice in response to SIG requests. In turn, the SIG would assign one technically qualified staff member to work at the facility.

Since that time, the aspirations of WorldFish Solomon Islands have evolved from ICLARM's originally purely technical aquaculture research to a broader commitment to improved coastal fisheries sustainability and benefits. Increasingly, this has been through action research, training and outreach with communities together with the SIG and its development partners.

Methods of Data Collection and Analysis

The WorldFish publications database and Science Direct were searched using combinations of the keywords Solomon Islands, WorldFish, ICLARM and MFMR, for literature by or about ICLARM/WorldFish and Fisheries Department/MFMR activities in Solomon Islands between 1986 and 2020. Ninety-two documents were either available online or from private collections and were reviewed by one author to develop a time-line of projects and partnership activities. The literature-derived timeline and relevant literature were then shared with the remaining authors who comprise current and past officers who have worked in one, or both, of the institutions between 1986 and 2020. All the authors initially critiqued the time-line individually, including the reliability of dates. Finally, each author contributed individually and in small groups, as remote communications technology allowed, to a longitudinal analysis of the characteristics of each organization's research and development activities over time. Each considered research power, priorities and capacity in each decade prompted by questions—how were decisions made on the research that was undertaken? by whom? what roles did each partner play in the research activities? The final compilation was reviewed and validated by all authors.

To analyze the characteristics of authorship of research outputs over time, metrics were compiled from the 88 publications remaining after excluding documents where

authorship was not attributed. Quantitative data on staff complements was sourced from the respective human resources departments of each organization.

RESULTS

The Partnership Timeline

A timeline was developed by decade, beginning in the 1980s and continuing through to 2020, to provide a convenient structure for examining key changes in the research and development context (**Table 1**). In the results section, a description for each decade is given in the form of a literature review with attention paid to the context of research power, priorities and capacity. The results section concludes by reviewing the evolution of a participatory research approach on the part of WorldFish in context of the partnership.

1980s

ICLARM established the Coastal Aquaculture Centre (CAC) in 1986 (**Table 1**) to tackle the development challenge of coral reefs no longer providing benefits to the people who lived near them [ICLARM (International Center for Living Aquatic Resources), 1995] and to support the aspirations of the SIG to develop aquaculture for marine commodities with high cash earning potential (Govan et al., 1988). A pipeline approach was explicit. The development challenge was to be addressed by "*developing ways to enhance the productivity of coral reefs, and by transferring the technologies to communities … in developing countries throughout the world … Results are reviewed by scientific peers and then passed to developing countries by training their key staff at CAC and through the publication of manuals and newsletters*" [ICLARM (International Center for Living Aquatic Resources), 1995]. ICLARM's 1986 report to the Pacific Community, formerly the South Pacific Commission (SPC) sets out the expectations for the new Solomon Islands site. "*The initial focus of the Center will be on the development of a pilot-scale giant clam hatchery to test and refine hatchery and nursery techniques and to provide seed for growing out under the wide range of environmental conditions offered by the Solomon Islands… The development of the Giant Clam Hatchery will be a collaborative undertaking between ICLARM and the GSI* (Government of Solomon Islands) *Department of Fisheries… There is provision in the agreement for the giant clam hatchery facilities of the Center to be sub-leased at a token rental to a commercial company owned by the GSI and GPG* (Guadalcanal Provincial Government)*, in the event that at some future date all parties agree that the operation of the hatchery on a commercial basis is economically viable*" SPC (1986).

In 1986, around 22 national officers in the Provincial Fisheries Section of the Fisheries Department had responsibilities solely related to coastal fisheries (i.e., excluding oceanic fisheries) (**Figure 1A**). One Provincial Fisheries Officer was based in Honiara and the remainder were seconded to the provinces. There was a gradually decreasing number of post-independence expatriates remaining in in-line positions (four in 1986) across the provincial and oceanic fisheries sections. Although there were degree-qualified national officers in senior departmental positions, in the provincial section, which comprised 100% men, the most highly qualified were the 40% of officers at the level of Fisheries Officer and above who had a diploma-level fisheries qualification (**Figure 1A**) (Mike Batty[1], pers. comm.).

The Fisheries Department came to rely on the ICLARM experts for scientific advice, as anticipated by the hosting agreement (**Table 1**). The expatriate ICLARM scientists brought external expert knowledge and imported technologies with respect to hatchery-based aquaculture of giant clams of the genera *Hippopus* and *Tridacna* (Govan et al., 1988). ICLARM's research expansion into commodities apart from giant clams was largely influenced by research happening elsewhere in the Pacific [ICLARM (International Center for Living Aquatic Resources), 1995]. These initial years were formative for the partnership as personal relationships developed and opportunities for learning emerged. Relatively greater control of research approaches and directions was vested in ICLARM scientists, characteristics in common with the "initiation, or initial networking stage" of research for development partnership (**Figure 2**) described by Prain et al. (2020).

1990s

In the early 1990s, Hviding (1993) identified that insufficient attention was being paid to the social and cultural context, and local knowledge, in ICLARM's participatory village grow-out trials (Govan, 1993). Advocating for a more holistic analysis of the basis for farming systems research and development, Hviding's (Hviding, 1993) recommendations reflected a move toward the more participatory systems approaches that were mainstreamed in the CGIAR in subsequent decades (Douthwaite et al., 2017).

During the 1990s, the ICLARM aquaculture facility established itself as an important source of knowledge and skills for aspiring Solomon Islands' marine biologists [Lincoln Smith et al., 2000; Ramofafia, 2001; ACIAR (Australian Centre for International Agricultural Research), 2012]. The Giant Clam Mariculture Project was described as a collaborative effort between ICLARM and the Fisheries Department, although the nature of this collaboration was not yet well-understood in the rural areas (Hviding, 1993). Nevertheless, routine visits to village trials provided an avenue for Fisheries Department staff to interact with rural people in a manner that was not otherwise possible due to inadequate resourcing of the department (Hviding, 1993). ICLARM scientists also undertook joint research projects with the Fisheries Department and other organizations, on topics that were not solely focused on aquaculture. This included the burgeoning field of Marine Protected Areas (Lincoln Smith et al., 2000).

Through this decade, the partnership characteristics began to resemble a co-ordination phase (**Figure 2**) (Prain et al., 2020). Relationships had been formed between individuals at the research facility and there was a growing understanding of what the facility could offer in terms of research outcomes. Yet Hviding (1993) identified a disconnect between the ICLARM project and the development activities of the Fisheries Department,

[1]Mike Batty was the Fisheries Extension Adviser in the Provincial Fisheries Section of the Fisheries Department from 1986 to 1990.

TABLE 1 | Summary of the institutional context for WorldFish (previously the International Center for Living Aquatic Resources Management; ICLARM) and the Ministry of Fisheries and Marine Resources (MFMR, previously the Department of Fisheries, within the Ministry for Natural Resources) of the Solomon Islands Government (SIG) in the small-scale fisheries and aquaculture sectors by decade, since 1986.

	Partnership elements and related context
1980s	• Initial project activities begin in Solomon Islands soon after ICLARM's creation in 1977 (Neal and Maclean, 1984) • The SIG invites ICLARM to establish an aquaculture research facility, via the 1986 SIG–ICLARM Agreement. • 1986: ICLARM begins building infrastructure for mariculture research with the primary objective of "creating a purpose-built giant clam hatchery" (Hviding, 1993). • International scientists and managers are recruited; hatchery-based research on giant clams (Govan et al., 1988) and extension trials (Govan, 1993) initiated, and a Fisheries Department officer seconded to the project as per the SIG–ICLARM Agreement. • Programme initiated to provide research opportunities for national research assistants to undertake higher degrees (SPC, 1989). • Throughout the 1980s, other donor-funded development projects in the Fisheries Department target rural fishers through the building of infrastructure and technology for rural fisheries centers (ADB, 2010) with little attention paid to other inputs or to creating an enabling environment for sustainability (Boape, 1999). • ICLARM research moves from hatchery production and initial village trial programme only, to expanded village trials for grow-out of clams on community reefs (Govan et al., 1988).
1990s	• ICLARM begins exploring other features, such as: social science research into the rural context for giant clam mariculture (Hviding, 1993); the impact and control of predators on ocean nursery clams (Newman et al., 1993); and the economics of giant clam farming (Hambrey and Gervis, 1993). • Projects were led by international researchers, with research station acting as a training ground for national technical assistants in the Fisheries Department [Lincoln Smith et al., 2000; ACIAR (Australian Centre for International Agricultural Research), 2012]. • Research expands to other commodities—sea cucumber (Ramofafia, 2001), pearl oysters, trochus and green snail [ICLARM (International Center for Living Aquatic Resources), 1995]. • Infrastructure at ICLARM facility destroyed during period of civil tensions [ACIAR (Australian Centre for International Agricultural Research), 2012]: hatchery-based international staff leave the country; skeleton national staff relocate from Honiara to small ICLARM satellite station near Gizo.
2000s	• Post-tensions, MFMR housed in poorly maintained and resourced buildings. An analysis for a New Zealand–funded in-house institutional strengthening programme (SIMROS) describes MFMR as having insufficient staff, training and opportunities to build skills, and a lack of stable senior leadership (Wilson, 2008) with relevant fisheries expertise. • Nevertheless, by leveraging prior research and personal relationships, some joint activities between MFMR and WorldFish continue, increasingly focused on community-based resource management (CBRM) approaches (Ramofafia et al., 2003; Nash and Ramofafia, 2006; WorldFish, 2009; Boso et al., 2010). • 2002: ICLARM is renamed The WorldFish Center. • 2006: Department of Fisheries and Marine Resources within the Ministry for Natural Resources becomes the MFMR (Brown, 2016). • Later in 2000s, national PhD-level marine biologist appointed as the Permanent Secretary of the MFMR (Wilson, 2008), following his role as a scientist in WorldFish. • By 2009, national development of the Coral Triangle Initiative National Plan of Action [MECM/MFMR (Ministry of Environment, Conservation and Meteorology/Ministry of Fisheries and Marine Resources), 2010] provides platform to align relevant government ministries and sector stakeholders toward approaches focused on CBRM. • Correspondingly, WorldFish clam and coral research adopts a goal of community livelihoods support (WorldFish, 2010). • Maturing MFMR articulates national aquaculture development plan (NADP) (SPC, 2009) with the support of regional organization The Pacific Community (SPC), and WorldFish scientists support MFMR developing its first Inshore Fisheries Strategy (MFMR, 2010).
2010s	• Early in the decade, New Zealand's in-house support to MFMR was extended, becoming the current (at time of writing) Mekem Strong Solomon Islands Fisheries (MSSIF) Programme [MFAT (Ministry of Foreign Affairs and Trade), 2013]. • WorldFish explicitly adopts systems approach to research, and coalitions of partners are prioritized as a pathway for research for development outcomes [CRP AAS (CGIAR Research Program on Aquatic Agricultural Systems), 2011]. • 2012 partner analysis identifies MFMR–WorldFish Solomon Islands partnership as being well-developed but of intermediate quality (determined by alignment of purpose, trust, common results and quality of relationship) (Schwarz et al., 2015). • 2015–16: MFMR initiates formal restructuring (MFAT, 2018) based on a functional analysis of roles against the new Fisheries Management Act 2015: - numbers of officers and senior managers with relevant tertiary qualifications increase; three new Divisions are created: Aquaculture, Policy and Project Management - CBRM unit in the Inshore Fisheries Department is elevated to a section with six dedicated staff - Corporate Plan (MFMR, 2015), Strategy (MFMR, 2017) National Fisheries Policy (MFMR, 2019) published. • In accordance with NADP, MFMR reclaims the old ICLARM site near Honiara and begins construction of a joint donor and SIG-funded tilapia hatchery. • CBRM scaling strategy is developed with stakeholders including WorldFish (MFMR, 2021).
2020+	• MFMR Corporate Plan 2020–2023 (MFMR, 2020) provides clear statement of how MFMR will implement SIG policies. • WorldFish reviews both its global and national strategies to ensure that research is relevant, credible, legitimate and effective (WorldFish, 2020).

which retained their late-1980s' focus on rural fisheries centers (**Table 1**).

The partnership then experienced a significant disruption. The 1998–2003 national civil unrest—referred to as "the tensions"—crippled major government institutions, and violence led to the largest known internal displacement (estimated 20,000 people) to have occurred in the Pacific region (Roughan and Wara, 2010). Not only was the aquaculture facility abandoned permanently by ICLARM after its infrastructure was destroyed, but the relocation of a skeleton staff to Gizo (**Table 1**) created a physical separation of ICLARM from the Fisheries Department headquarters in Honiara.

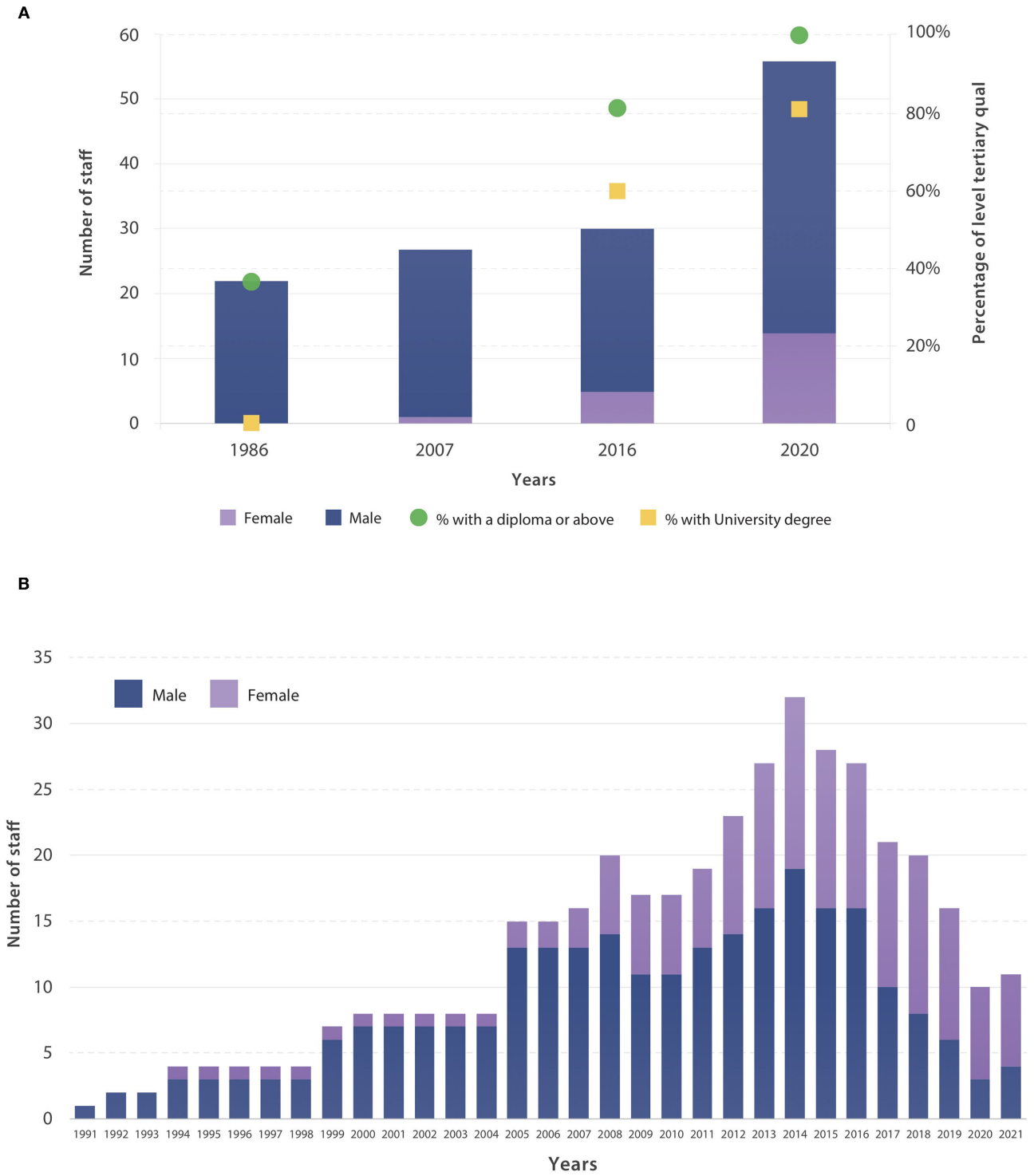

FIGURE 1 | (A) MFMR national staff in technical divisions focused on coastal fisheries management and community development. All years represent filled positions to the extent it could be ascertained from available data. 2007 is an overestimate of filled positions as it was not possible to disaggregate the data into filled and vacant posts, nor were data on staff qualifications available. (Sources: Govan et al., 2013; MFMR and MSSIF Human Resources Sections; Mike Batty, pers. comm.). **(B)** WorldFish staff in Solomon Islands. These staff do not include overseas-posted staff who travel to Solomon Islands in programs and projects. (Source: WorldFish Human Resources Department).

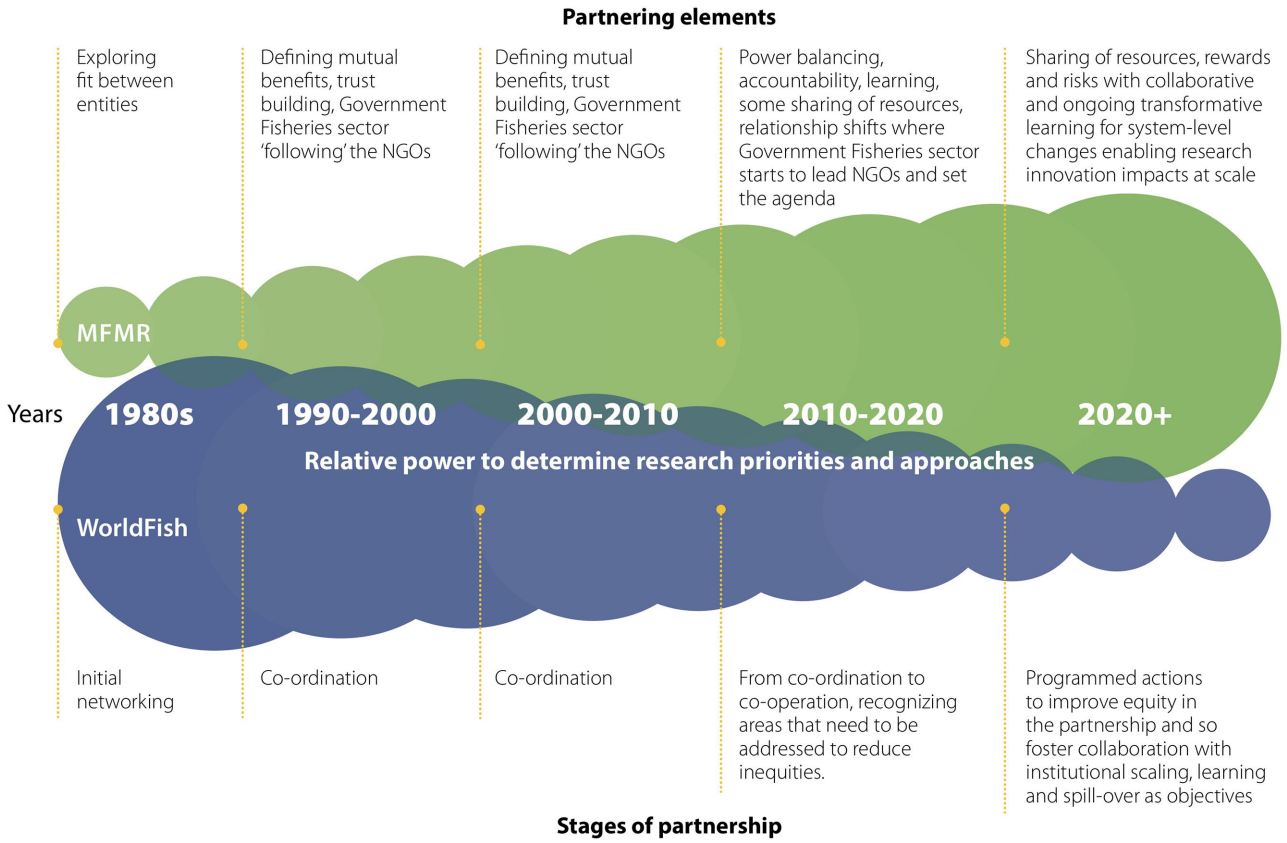

FIGURE 2 | The differences in relative participation, collaboration and power between MFMR and WorldFish to determine and direct research for development needs over time, mapped to the stages of a research-development partnership, adapted from Prain et al. (2020), and including themes of equity described by Price et al. (2020).

2000s

The turmoil of the tensions had the potential to be a significant hurdle for the partnership. However, ICLARM was able to maintain reduced activities through and beyond the period of disruption with a complement of skilled national staff supported, both in country and remotely, by expatriate researchers (Hair et al., 2000). The partnership was considered extant, based on the Fisheries Department continuing to support ICLARM's (renamed The WorldFish Center in 2002) project proposals to donors.

As Solomon Islands entered a phase of rebuilding public infrastructure and governance (SIG and RAMSI, 2017), the newly created (in 2006) MFMR benefited from an in-house New Zealand–funded institutional strengthening programme (Wilson, 2008). The presence of international technical aides within the MFMR and the fact that WorldFish was now located in Gizo—far from the nation's capital—meant that WorldFish was no longer the first port of call for scientific advice.

The MFMR was focused on improving working conditions (building new infrastructure) and increasing capacity for fisheries officers and managers to effectively participate in boosting revenue from the nation's tuna fisheries (Aqorau, 2019). This included developing a fit-for-purpose Fisheries Act to replace that of 1998. Although joint coastal fisheries activities between MFMR and WorldFish occurred when funding allowed, these interactions were seldom jointly planned beyond courtesy visits, and tended to focus on development challenges identified by WorldFish researchers in the absence of a national development strategy[2] or relevant MFMR policies. For WorldFish, an aquaculture commodity development focus prevailed in the early 2000s. van der Ploeg et al. (2016) observed that researchers at the Gizo field station had studied the distribution and abundance of pearl oyster spat, developed giant clam and coral culture for the international aquarium trade, and undertaken studies of commodities such as sponges, but that it was becoming clear that most small-scale aquaculture enterprises were not economically feasible.

In the latter part of the decade, several initiatives aligned to give increased clarity to the direction that small-scale fisheries management and development would take in the Pacific region. In 2007, WorldFish focused its global research strategy toward small-scale fisheries management (Andrew et al., 2007) and, in line with the earlier calls in Solomon Islands by Hviding

[2]Solomon Islands published the first National Development Strategy in 2011, to replace a 2008–2010 Medium Term Development Strategy.

(1993) and global discourses on participatory development (Pretty, 1995), targeted participatory community-based resource management (CBRM) approaches. This included building the capacity, through training and mentoring, of international and national researchers to facilitate action research (Douthwaite et al., 2017).

Since the late 1990s, CBRM had been gaining traction and by the 2000s was an innovation around which natural resource management stakeholders mobilized. In the MFMR in 2007, 27 positions were allocated to roles aligning with coastal fisheries activities (Govan et al., 2013) although not all were filled (**Figure 1A**). Activities conducted under the auspices of the Coral Triangle Initiative (CTI) National Plan of Action (MECM/MFMR, 2010) (**Table 1**) resulted in the creation of several locally managed marine areas (LMMAs). Stakeholder networks of government, NGO and community representatives received project funding that enabled periods of active engagement in sharing of knowledge and strategy development related to CBRM (Govan et al., 2009). Both MFMR and WorldFish played an active role; for example, WorldFish managed funds for an MFMR-based Locally Managed Marine Area (LMMA) network co-ordinator from 2011 to 2012 when donor constraints precluded funds being given directly to the MFMR.

The overall success of these grassroots resource management initiatives was mixed however, as communities faced multiple and often conflicting challenges, many from outside the fishery itself. These included an increasing need for cash, poor access to markets, impacts from forestry on land and reef ecosystems, climate change, and gender and social inequities (Boso et al., 2010; Govan et al., 2011; Cohen et al., 2014). During the re-building and a re-orientation phase of the 2000s (**Table 1**), WorldFish research was seen as scientifically credible (as determined by peer-reviewed publications) and relevant (e.g., aligning with the CTI National Plan of Action). Nonetheless, there was a need for more attention to research legitimacy and effectiveness, key areas to address for CGIAR research broadly (ISDC, 2021), to produce meaningful solutions at scale for small-scale fishers. As a theorized scaling pathway for CBRM, there is little evidence that the partnership between MFMR and WorldFish had moved beyond the co-ordination phase of the 1990s.

The MFMR–WorldFish relationship persisted through this decade on the strength of personal relationships. Despite significant changes in context, capacity and research direction in both organizations, and despite attempts by WorldFish to revise the original 1986 hosting agreement, there has to this day been no formal re-articulation of mutual goals and objectives and the 1986 hosting agreement remains the foundational document.

2010s to 2020

Working from a new purpose-built building from 2012 onward, the MFMR gazetted the Fisheries Management Act in 2015, and established a clear policy environment through a suite of documents (**Table 1**) aligned to SDGs and the National Development Strategy.

By 2020, the MFMR was staffed by around 130 people with seven separate divisions arranged to optimize delivery on its clearly articulated mandate (MFMR, 2019, 2020). Fifty-six of these staff (including divisional leaders) were assigned to activities related to coastal fisheries. The new staff had skills and qualifications relevant to coastal fisheries management and research, policy and aquaculture. Now 25% were women and more than 85% had a minimum of an undergraduate university degree in a relevant field of study (**Figure 1A**).

In recent years, financial support from development partners has provided operational funds directly to the MFMR to complement annual SIG allocations (MFMR, 2018). The Mekem Strong Solomon Islands Fisheries (MSSIF) Programme for example, implemented by the MFMR in partnership with the New Zealand Government, transitioned from a programme with a parallel workplan addressing identified gaps in the MFMR to directly funding the MFMR annual workplan to tackle policy issues identified by the SIG. Hence, MFMR officers in the coastal fisheries sector not only have power as determined by statute and are more empowered by supporting policy but are in a better position to fund some of their own activities. Nevertheless, operational funds remain limited and time-bound, and priorities are determined by the mandate of MFMR to implement SIG policies.

Since 2000, WorldFish Solomon Islands has employed more than 50 Solomon Islanders with relevant university degrees, including at MSc and PhD level, on short- (1–2 years) and long-term (up to 10 years+) contracts (**Figure 1B**). The overall management is the responsibility of a national officer who reports to WorldFish headquarters in Penang, Malaysia. Over this period, the WorldFish modality has been that international WorldFish scientists are either based in Solomon Islands for periods of time (sometimes years) or visit for short periods to contribute within their area of expertise. The number of nationally based staff and visiting scientists at any one time has waxed and waned as a direct reflection of the size and scope of projects and programmes (**Figure 1B**). A WorldFish–Solomon Islands Visitors Orientation document from 2014 references the importance of local relationships and hints at some of the tensions that can arise through such a research modality, even within one organization. Instructions included: *"The … team has over many years built up an extensive network of contacts from the community level to senior government officials. Maintaining good relationships is central to our ability to work effectively …. work closely with in country staff and take their advice on what may or may not be appropriate in terms of planned research activities, meetings and field trips. Respect the knowledge of the local team."* The partnership between WorldFish and the MFMR is the central relationship referenced here.

Participatory Research

From 2012, WorldFish research moved steadily from action research to increasingly participatory approaches in which local stakeholders, including smallholders and their families, had a say in research design and direction, and where it was recognized that the small-scale fisheries and aquaculture activities at the time needed to be embedded in the wider development context

[CRP AAS (CGIAR Research Program on Aquatic Agricultural Systems), 2011]. This required not only participatory research processes with smallholders and their families but also similar engagement with stakeholders at all scales of governance to build a more enabling environment for innovation and change (Apgar and Douthwaite, 2013). Accordingly, a need was identified to increase the quality of the MFMR–WorldFish partnership for improved development outcomes (**Table 1**). In practice, WorldFish aspirations to build coalitions beyond the fisheries sector alone, and a limited bandwidth for nationally based WorldFish researchers embarking on an ambitious systems-level programme, meant that the MFMR–WorldFish partnership was not especially privileged over others. One MFMR key informant described their perception of the recent, participatory and community-focused approach of WorldFish as working in the same way as "just another NGO" rather than reflecting any special position.

At the same time the MFMR aspires to increase the influence of its research section on policies and fisheries management (MFMR, 2017). With regard to this we explored the metrics of authorship on scientific publications as just one indicator of how the research-development partnership with WorldFish has contributed to or could contribute to this aspiration. Between 1986 and 2020, ICLARM/WorldFish researchers published at least 88 peer-reviewed scientific articles, open-access reports, plans and briefs specific to Solomon Islands research. Of these, 35 (40%) were authored solely by researchers who were not Solomon Islanders. Of the remaining 53 documents that had a Solomon Islander, from any institution/affiliation as an author (13 of these as first author), 77% were published after 2010. Only 10 of the 88 publications had at least one author from the Fisheries Department/MFMR—the first in 1988 (Govan et al., 1988) and subsequently once every three years, on average, to 2020.

A *post-hoc* analysis of the WorldFish-led CGIAR Research Program on Aquatic Agricultural Systems (CRP AAS), which ended in 2016, identified four ways of working across diverse global geographies as being central to the successful elements and research quality of the programme (van der Ploeg et al., 2016; Douthwaite et al., 2017): (i) adopting a systems perspective; (ii) committing to effective community engagement; (iii) building capacities across all relevant stakeholders including communities, researchers, government agencies and other participating organizations; and (iv) investing resources, time and learning to develop and maintain partnerships. These elements continue to be reflected in WorldFish Solomon Islands' approach (WorldFish, 2021). However, a difference is a renewed centrality of the MFMR implicit in the re-centering of fisheries in subsequent projects. One result of this has been a WorldFish officer (fully funded and with operating funds for targeted activities) seconded into the CBRM section of the MFMR to help build capacity and deepen the mutual understanding of the culture, context, constraints and opportunities of each partner.

The changes in WorldFish's ways of working since 2013 are, in part, responsible for persistent inequity being identified in the contemporary WorldFish–MFMR partnership. Problems include: insufficient recognition of the modern capacity of MFMR staff; engagement modalities that rely on a few longstanding personal relationships; and insufficient awareness of the impact of significant disparities between the two organizations in accessing funds for activities. This has led, in part, to a call for a re-evaluation of the research for development partnership that we discuss in this paper.

Beyond 2020

On the face of it, the increased operational and thought-leadership capacity in the MFMR and the aspirations for high-quality science articulated by WorldFish since the late 2000s appear to have created conditions where both partners are better able to identify and facilitate more co-operative and collaborative elements of the relationship. As described by Prain et al. (2020), this would mean there is a "*stronger focus on identifying the mutual benefits of joint participation in the innovation process*" and "*pooling of resources and sharing of risks, and full 'buy in' to the innovation by the regime.*"

Accordingly, at this stage of a so-defined collaborative research-development partnership, scaling of an innovation such as CBRM and associated livelihood advances would be largely driven by the MFMR. Research findings and jointly generated knowledge would be reflected in policy, relevant scaling strategies would be in place and the MFMR would be allocating funding and resources to the task. This is in fact the case to some extent, but in practice, the MFMR has less funding than is required to take on the scaling role and it remains necessary to nurture agreements with partners to further scaling ambitions.

DISCUSSION

Research Power, Priorities and Capacity

Fundamentally, research partnerships exist for different reasons depending on the partners involved and their objectives (Stokes, 1997). For example, partnerships can focus on: exchanging skills and catalyzing further research collaboration [ACIAR(Australian Centre for International Agricultural Research), 2021]; advancing knowledge through transdisciplinary collaboration (Moon et al., 2016); or seeking to take a specific research innovation to scale (e.g., Wigboldus et al., 2016). Our analysis of 35 years of the MFMR–WorldFish partnership shows that the reasons underlying one particular partnership can also change, reflecting changes in research power, priorities and capacity through time.

Power can be a key lever for shifting partnerships (Price et al., 2020). Levers are areas within a complex system where a small shift in one thing can produce big changes in everything (Meadows, 2020). In our case, power has historically been related to resources and capacity. The stages described in the framework for research-development partnerships help in gauging the elements of power and equity. Our assessment represents a gradual shift over time toward more equitable planning through deliberate integration. The direction of the opposing and overlaid circles in **Figure 2** is a compelling representation of the shifting gradients of relative participation, collaboration and power in determining and directing research for development needs over time.

In the initial networking stage of the partnership, ICLARM researchers sought to generate mariculture-based livelihood

innovations with limited consideration of how to be impactful at scale—a common feature of localized initiatives at the time (Uvin and Miller, 1996). While there is evidence that these investments were formative for a small community of national researchers who would go on to be national champions for sustainable marine resource use (Davila et al., 2017), the long-term benefit to people in Solomon Islands was very minor. The Fisheries Department, having recently emerged from a colonial administration, was new to aquaculture and to government's role in coastal fisheries management. During this period, ICLARM held the funds and the external knowledge of hatchery-based aquaculture, and so, despite being in Solomon Islands at the invitation of the SIG, held significant power to decide on research direction (Govan, 1997).

Over time, the MFMR has increasingly been able to identify and communicate its own research needs through increased staff capacity and through developing and publishing its own policy. It is also able to dedicate limited resources to implementation of scaling activities by trained officers. Both WorldFish and the MFMR explicitly emphasize the importance of partnerships in their policies and strategies as an enabling condition (Lomonico et al., 2021) to achieve a sustainable fisheries sector that contributes to the socio-economic needs of all Solomon Islanders. Implicitly, both partners seek impact at scale through system-level changes in practices and planning. However, WorldFish retains significant power to determine research activities through its external and relatively independent funding. A move toward true equity and co-production now requires broader acknowledgment of the power differences that different funding flows and academic standing can create, and true co-identification of research needs between WorldFish and the MFMR with associated co-production of outputs, to improve the enabling environment for innovation at the community level.

Embedding CGIAR Research in National Development Trajectories Is a Pathway to Scale

Like other CGIAR centers across the world, WorldFish prioritizes commitment to national partner agencies, which is arguably why CGIAR research is recognized for its unique research mandate (Anon, 2020). The research programme approach continues to be guided by accepted wisdoms such as Chambers' (Chambers, 1983) request to "reverse" thinking in development, research and associated approaches, based on a key principle that the research process itself creates opportunities for change when done in collaboration (Cameron and Gibson, 2005; Cameron et al., 2014). Increasingly, the literature on scaling agricultural innovation frames the opportunity for impact through this way of working (e.g., Wigboldus and Leeuwis, 2013; Wigboldus et al., 2016; Shilomboleni and De Plaen, 2019).

The institutionalization of CBRM in the Pacific is an example of a scaling/sustainability innovation of sorts, having transitioned toward a mode of multi-stakeholder interaction across scales (Steenbergen et al., 2021). This is important because CGIAR research has been criticized for overinvesting in natural resource management without clear evidence of its impact, in contrast to, say, crop breeding programs that are more amenable to pipeline-framed impact assessments showing clear value for money (Renkow and Byerlee, 2010). Partially, such critiques have been rebutted by a more nuanced understanding how research impacts on sustainability and policy through "system level change" and "contributory cause" by Mayne and Stern (2013). At any rate, our case study exemplifies the very complex and long-term journey of change: there is no straight line of attribution, rather there are many meandering paths of contribution through time. Change takes places at many levels and straddles project and programme generation cycles and is unlikely to have happened without investment (e.g., Sukulu et al., 2016). This is a strong reason why explicit emphasis on commitment to the continuous evolution of a respectful partnership is so important.

Embedded approaches are critical for the type of framing for scaling described by Steenbergen et al. (2021) and rely on recognition that there are different knowledge systems and actors that influence outcomes. WorldFish's research seeks to be increasingly embedded within national development trajectories, recognizing the potential for research impact as arguably greater than the scientific publications produced in its previous 35-year history of Solomon Islands operation. For example, in 2021, the WorldFish operational plan for Solomon Islands stated the vision of the MFMR Corporate Plan as its goal (WorldFish, 2021). But planning for the WorldFish programme also includes other partners, such as national higher education institutions and provincial-level governance structures, because different partners have different roles to play in national development.

Given the stated alignment of purpose among multiple organizations in the small-scale fisheries sector, a challenge is to determine how WorldFish resources, time and determination are best allocated to ensure that all four elements of research quality are met to facilitate learning and uptake of innovation (Kristjanson et al., 2009; ISDC, 2021). Adopting (i) systems research, (ii) community engagement, (iii) building and resourcing capacities and (iv) partnerships as ways of working (van der Ploeg et al., 2016; Douthwaite et al., 2017), are identified as areas that can be strengthened to improve research quality and equity in the partnership (**Figure 3**). Addressing partnership equity is consistent with current debates on the decolonization of science and the increasing realization of parachute researchers sidelining local researchers in their own countries (Elliott, 2021; Watson, 2021). The elevation of this narrative helps legitimize the path that many individuals in the partnership have chosen over time; one not motivated primarily by academic outputs as the primary form of knowledge (see also Davies et al., 2021). Notably, these areas are anticipated to increase legitimacy and effectiveness; the elements that were identified in this study as having been paid insufficient attention in earlier decades. Our suggestions to improve such practice comes at a critical time as the CGIAR is evolving into One CGIAR. The CGIAR Independent Science for Development Council (ISDC) has highlighted legitimacy and effectiveness as the historical areas most challenging for CG centers to mainstream into planning management and practice (ISDC, 2021).

For WorldFish, there are tensions and trade-offs in being locally impactful and globally relevant. Global agendas and

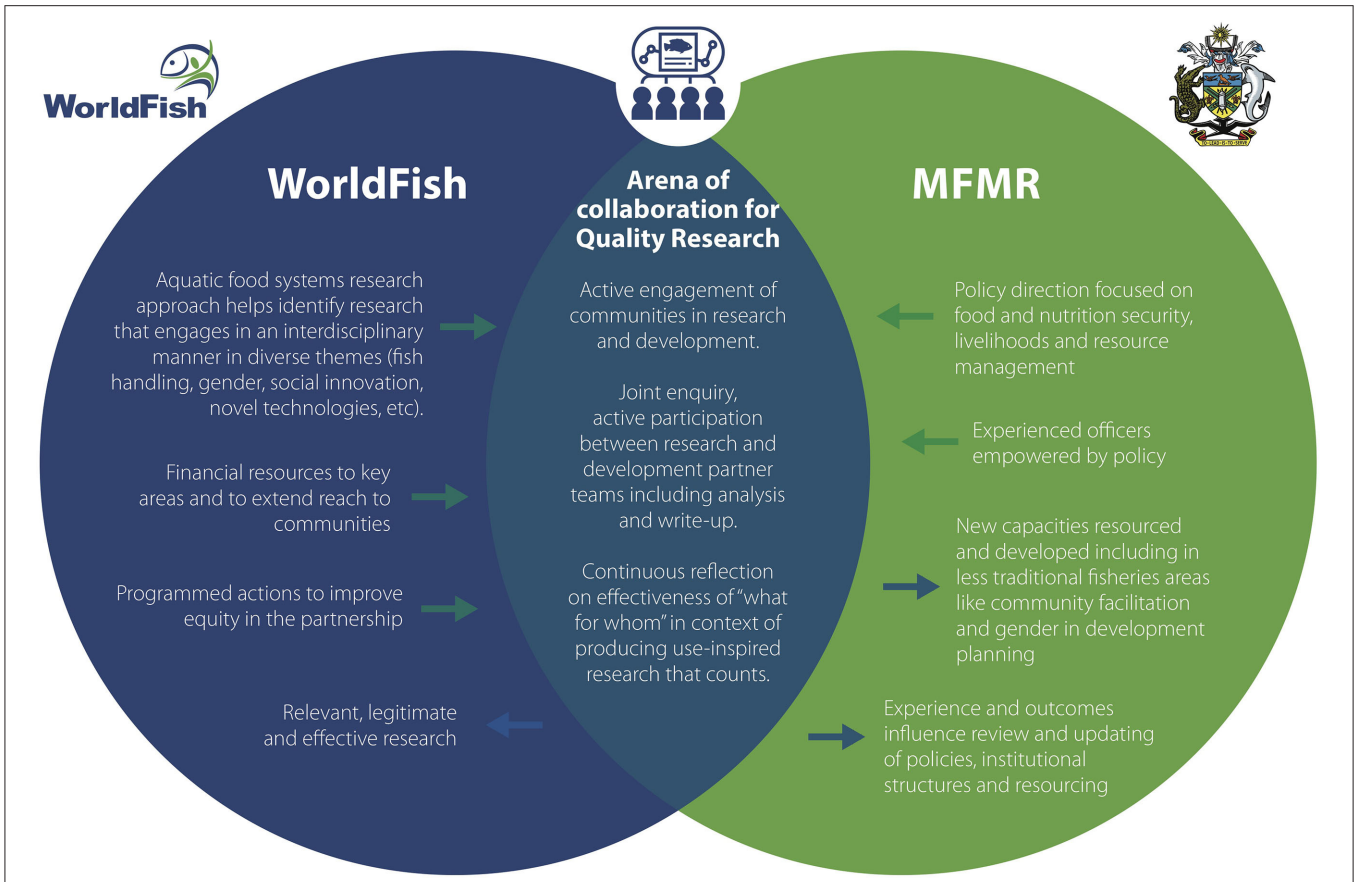

FIGURE 3 | The proposed interface of collaboration for high-quality research between WorldFish and the MFMR, specific to this research-development partnership case.

priorities can change in a matter of months, while local challenges often remain the same for decades. Across the many organizational layers within which WorldFish operates, from community research to the strategic direction of CGIAR research, the foundational building blocks of a legitimate research collaboration may have been somewhat invisible at times and perhaps taken for granted by programme leaders focused on academic outputs and far away from the everyday realities of the in-country program. The challenges to operating a research programme that is nationally relevant and internationally recognized are sometimes unexpected. Requests by marginally associated scientists for WorldFish to arrange activities on their behalf are frequent; sometimes these come directly or sometimes donors promote a collaboration as advantageous to their financing. If WorldFish is to play an enabling role for external researchers while retaining a respectful partnership with the MFMR, then, by extension, outside expert requests must mirror and support how WorldFish is imagining its embeddedness within national development trajectories.

The persistence of the partnership described here despite significant change in context over time, including some disruptive shocks, is largely attributed to the existence of long-term trusted relationships among individuals and historical memory of the role that ICLARM played in the early careers of today's fisheries managers and sector leaders in Solomon Islands. Arguably, in the absence of the unique research facility that characterized those early days, WorldFish has not since played such a key role in the careers of the next generation of fisheries managers. However, a form of partnership has persisted, drawing strongly on personal relationships, educational bonds and common interests across technical working groups. A strength of the new MFMR is the increasing depth of leadership capacity, and the opportunity to continue contributing to that lever for change persists for WorldFish as a partner. The long-term commitment to people and places by the partnership, and the shared and open ambition to support national development and research objectives, provides credible research for development opportunities built on mutual trust and objectives. Over the last decade, the MFMR has transformed toward much greater capacity to determine their research needs, a journey that is likely to continue, and so partners must consider how to best be part of this development trajectory.

CONCLUSIONS

Within an aquatic food system, there are multiple innovations at different stages of scaling across different time frames. The challenge for partnership programs of this kind is to ensure the

relevance, credibility, legitimacy and effectiveness of research that aims to develop and scale innovation for improved livelihood outcomes for individuals and families. Research legitimacy and effectiveness, both foundational elements of research application, requires mutual trust and understanding among partners who connect with the development challenge at hand, trust which can take years to nurture (ADB, 2011; Schwarz et al., 2015). Even then, the context is not static and partners are expected to change along a continuum as a programme evolves in time and space (Horton et al., 2009). For example, as in our case, successful partnerships often require a set of individual trusted relationships to be formed, so changes in staff and staff responsibilities can challenge the dynamics of the relationship (Aqorau, 2019). Aspects of power and control shape participation between partners and project recipients. For example, scientific and expert knowledge can assume dominant roles in partnerships that co-produce knowledge (Offermans and Glasbergen, 2015). Analogs of these power imbalances can be identified in development relationships between an externally well-funded institution staffed by perceived experts and a poorly resourced national agency in the recipient country (Cornwall, 2008). In our case study, capacity and resourcing differentials between the partners created imbalances in power and priorities at different times, which arguably hindered the potential development impact of emerging innovations. However, a major feature of our analyses is the growth in capacity of the MFMR over the last decade.

Previous arguments about the MFMR's lack of capacity in human resources and policy clarity are no longer a compelling rationale for researchers to pursue externally prioritized research regardless of the degree of participation by the MFMR. In this regard the MFMR is unlikely to be an isolated case. Therefore, changes are required to ensure that high-quality research results in better support of outcomes for fishing families via research for development partnerships. The case suggests the following principles as guiding for theories of change through such partnerships:

- Partnerships for scaling need to be nimble and adaptable. Rather than trying to find a moment when the partnership had achieved some nirvana of collaboration, we propose that an explicit recognition of the need to focus on adaptability, flexibility and trust to be able to acknowledge and address issues of inequity is a more fruitful approach to nurture.
- Structural steps to be taken toward research for development integration. For example, seconded staff can facilitate greater involvement of Government officers in projects and shared operating budgets. But also important, is how researchers' roles are defined and evaluated, with less emphasis on academic merit and more emphasis on co-production.
- Programmed actions to co-produce sustainable development solutions in aquatic food systems. Different knowledge systems and actors influence development outcomes. The ability to nurture equitable and effective partnerships often underpins assumptions about the expected outcomes of research for development activities. To address equity in partnerships necessary for adoption and to learn from outcomes there must be sharing of power among national agencies, indigenous leaders, academics and community groups.

AUTHOR CONTRIBUTIONS

A-MS and HE conceived the research and developed the methodology. A-MS conducted the analysis and curated the data. A-MS, HE, CR, RM, DB, and HG validated the analysis. A-MS and HE wrote the paper with regular reviews and edits by CR, RM, DB, and HG. All authors validated the analysis.

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