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Value chain analysis of a women-dominated wild-caught mud crab fishery

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Abstract

A value chain analysis (VCA) is a cost-effective tool to guide targeted value chain development interventions to address social wellbeing and environmental performance. Examining value chains through a gender lens can help design and implement interventions that enhance opportunities for women in the fisheries and address gender inequalities in the sector. We conducted a VCA in 2015 of the wild-caught mud crab (*Scylla serrata*) fishery in Bua Province, Fiji. We found five main players involved in the selling of mud crabs – fishers, traders, retail shops, restaurants and exporters. The value chain was dominated by Indigenous (iTaukei) women fishers (88.1% of fishers) and characterised by low technological input, targeted largely for domestic markets or consumption, and with limited value-adding activities. Although most women harvested mud crabs on a part-time basis, it was an important source of income for most with 30% relying on it as their main livelihood. Despite being a lucrative commodity, there are several bottlenecks in the fishery – the relative informality of relationships amongst players in the value chain, the independent livelihood-driven harvest behaviours of fishers, and opportunistic sale of products. As a result, the fishery did not meet the demands of the domestic market. Our study concluded the gendered-skewness in the fishery increases the vulnerability of the chain to declines in economic productivity because of its reliance on irregular suppliers, and gender-based constraints. However, the low frequency and intensity of harvesting and use of low technological harvesting methods meant the fishery was not over-exploited and likely sustainable.

KEYWORDS
coastal fisheries, Fiji, gender, livelihoods, supply chain, value chain development

1 | INTRODUCTION

Fisheries represent a crucial nexus between marine ecosystems, global economies, and the sustenance of millions worldwide. Globally small-scale fisheries account for 40 percent of fisheries catch and provide jobs for more than 90 percent of people employed in capture fisheries value chains, including women (FAO et al., 2023). Aquatic foods play a key role in food and nutrition security, providing protein, omega-3 fatty acids and essential micronutrients, particularly for those in the Global South (Hicks et al., 2019). The intricate web of processes that brings fish from the oceans to our tables constitutes what is known as the fisheries value chain. This chain encompasses an array of activities, from harvesting to processing, distribution, and consumption, all of which contribute significantly

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to economic growth, food security, and employment in numerous regions (FAO et al., 2023).

Small-scale fisheries are important to coastal communities in the Pacific contributing to household nutritional security and local livelihoods (Bell et al., 2009), with women providing a disproportionate contribution (approximately 80%) to communities' annual subsistence requirements in Melanesia (Kronen & Vunisea, 2009). Invertebrates make up an important component of Fiji's coastal fisheries and have been valued at US$3.39 million annually (Gillett, 2016) and are heavily utilised by rural communities for food and livelihoods (Gillett & Fong, 2023; Thomas et al., 2021). Unfortunately, 'boom and bust' exploitation over the last few decades coupled with decades of poor management has resulted in declines in invertebrate stocks, especially close to urban centres (Mangubhai et al., 2019).

The supply and value chains of the highly lucrative mud crab (*Scylla serrata*) fishery has not been mapped out and described in Fiji. Despite the volume of mud crabs sold at domestic markets and along the roadside, there is very little historical information on the fishery (Lee et al., 2020). Market data collected by the Ministry of Fisheries in the early 1980s estimated sales of mud crabs to be just over 40 metric tonnes, which later increased and fluctuated between 70 and 140 metric tonnes annually between 1983 and 1991 (Richards, 1994). During this period, sales were largely to shops, hotels and restaurants and little ended up in municipal markets. The legal size limit (12.5 cm carapace length) is not regularly enforced and markets such as Suva and Nausori sold large volumes of undersized mud crabs (Vunisea, 2016). Catch per unit effort surveys conducted in 2017–2018 by local fishers in Vanua Levu found skewed sex ratios and smaller sized mud crabs in mangrove areas close to major markets (Wildlife Conservation Society, unpublished data).

Recognising the increasing value of wild caught mud crabs in Fiji, we conducted a value chain analysis (VCA) of the fishery to: (1) map and analyse the role and relationships between players (section 4.1); (2) understand how much value adding is done along the value chain (sections 4.2 and 4.3); (3) determine the flow of payment and how prices are determined (section 4.4); and (4) identify the barriers and opportunities to industry growth and competitiveness in the fishery by exploring values of different stakeholders engaged in the value chain (section 4.5). Each of these components are explored through a gender lens. Analysing the value chain of the mud crab fishery is crucial to safeguard against excessive exploitation that primarily favours commercial interests, while also ensuring the equitable participation of women in a sustainable fishing industry. This examination helps to mitigate the risk of displacing women from their roles within the fishery and maintains a balance between economic gains and environmental conservation (Ferguson, 2021).

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2 | THEORETICAL APPROACH

A VCA can shed light on the factors that affect the flow of benefits and constraints to the performance of small-scale fisheries, the players involved and their interactions, the service providers that support value chain operations, and the enabling environment (e.g. policies, institutions, infrastructure) that governs or influences a fishery (Fabinyi et al., 2018; Ponte et al., 2014). It can highlight opportunities for performance improvement, response strategies to increase efficiency and effectiveness of the value chain address market inequalities, and ultimately leading to improved financial positions for players, including women in the value chain (Ponte et al., 2014; Rosales et al., 2017). These improvements might involve discrete economic investments or reduced exposure to risks, and may extend to other outcomes including gender, labour, poverty and the environment (Riisgaard et al., 2010). It can contribute to more sustainable fisheries by understanding of economic or market drivers that influence the rate or volumes of extraction of fisheries resources, and to identify ways to minimise the wastage (Mangubhai et al., 2016).

Quantitative studies are often the primary focus of value chains, assessing the distribution of wealth and differential financial gains of products as they are transmitted through the chain. A value chain approach can be enhanced further by engaging with qualitative analyses, particularly relational values expressed in the chain, and the socio-cultural or political contexts the chains operate in (Fabinyi et al., 2018; Kruijssen et al., 2018), and can reduce inequalities (e.g. gender) beyond financial.

Gendered labour markets and gender relations are diverse, often complex and dynamic, and may shape opportunities for participation and access to resources within a value chain (Elson, 1999). These dynamics influence or dictate various aspects, from the range of job opportunities available to women and men, to the discernible contrasts in income earned, and the qualitative aspects of individuals' roles within these chains, such as time allocation, access to labour-saving technologies, and involvement in decision-making (FAO, 2016).

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Women's roles in fisheries are often shaped by their ethnicity, religion and socio-economic status, as well as social and cultural gender norms (Ferguson, 2021; Fröcklin et al., 2013; Galappaththi et al., 2021; Lawless et al., 2019). Women's contributions to the fisheries sector are often overlooked, underestimated, and undervalued, despite being major players along the value chain in small-scale fisheries (Kleiber et al., 2015; Thomas et al., 2021; Weeratunge et al., 2010; Williams, 2020). Part of this stems from the way countries collect and collate national statistics, focusing on fish more than invertebrates, commercial fisheries only, and exclude the wider diversity of activities along the value chain such as pre-harvest work (e.g. maintenance of nets, bait preparation), post-harvest processing (e.g. sorting, gutting, cooking, drying, salting), trading and distribution (FAO, 2016; Galappaththi et al., 2021; Weeratunge et al., 2010).

Economic transformations intrinsic to value chain enhancements significantly influence gender relations. For instance, interventions aimed at enhancing women's involvement in productive activities within specific value chains can either augment or diminish their access to and authority over financial resources. 'Gender-neutral' value chain development (i.e. where gendered aspects are not considered) may therefore, progressively exclude women, particularly those with limited access to technology and resources (Ferguson, 2021; Galappaththi et al., 2021). Taking a gender-sensitive approach to mapping the value chain represents a crucial initial stride in bringing visibility to women's labour and engagement within a value chain (FAO, 2016; Mayoux & Mackie, 2008).

3 | METHODS

Fiji has the third largest mangrove area (424.6 km^2) in the Pacific after Papua New Guinea and Solomon Islands (Mangubhai et al., 2019), with extensive stands in Bua Province on the island of Vanua Levu. Mangrove stands and adjacent habitats support a diversity of locally important women-dominated fisheries, including mud crabs (Thomas et al., 2019, 2021). These mangroves are within customary fishing grounds (*qoliqoli*) which extend from the foreshore to the outer edge of the barrier reef, are subject to a dual system of management under both customary and statutory laws (Mangubhai et al., 2019). While Indigenous Fijian (iTaukei) communities may have the access rights to harvest resources, the State retains the power to legislate or regulate resource use and does so for all commercial fishing within customary waters.

We conducted a VCA for the wild caught mud crab fishery in Fiji. Firstly, using local expertise (i.e. Ministry of Fisheries staff, NGO fisheries practitioners) we mapped out the supply chain visually for Fiji and compiled a list of known players operating in Bua Province. Secondly, we developed a VCA questionnaire by adapting socioeconomic questionnaires designed and successfully applied by Wildlife Conservation Society for the sea cucumber fishery in Fiji (Mangubhai et al., 2016).

The majority of the VCA survey was conducted between 23 November and 20 December 2015. Consumer preference surveys done between March and July 2016 at the Labasa and Suva municipal markets (Figure 1). Although we did not look at value chains on the island of Viti Levu, we wanted to compare consumer markets in Suva, given there is increasing movement of seafood from different parts of the country to the capital. We used a snowballing sampling strategy where the questionnaire for fishers was administered first to enable the team to collect the names and contacts of people and businesses that fishers sold mud crabs to. We used purposive sampling to reach different players in the value chain, with different levels of investments. Interviews were done in English, Fiji-Hindi or iTaukei languages after informed consent was given. We interviewed 148 people, comprising 109 fishers who harvest mud crabs, 9 boat owners who provide transport to mud crab fishers, 10 traders, 6 seafood shops/retailers, 3 resorts, 1 hotel, 6 restaurants, and 2 exporters. We conducted fisher interviews in 20 selected coastal villages in the districts of Bua ($n=2$), Dama ($n=3$), Kubulau ($n=3$), Lekutu ($n=3$), Nadi ($n=2$), Navakasiga ($n=2$), Solevu ($n=1$) and Wainunu ($n=4$) in Bua Province, on the island of Vanua Levu in Fiji (Figure 1). We interviewed 91 consumers at municipal markets in Suva, Labasa, Savusavu and Nabouwalu, to understand consumer choices and preferences. While some mud crabs are exported, this VCA focuses on the domestic supply chain in Fiji.

The questionnaires were semi-structured, with questions designed to examine a range of variables tailored to targeted players in the supply chain. For fishers ('upstream' players), questions covered harvesting techniques, use of harvest, fishery health and management, alternative livelihoods, expenses and sales estimates. Traders, exporters, seafood shop retailers and restaurants ('downstream' players) were asked questions on purchase criteria, purchase arrangements, supply and sales. The term 'trader' is defined in this paper to mean both middlemen and middlewomen that are buying and selling in the fishery. Prices were converted using international exchange rate of 1 FJD = 0.47 USD. Percentages presented were rounded up to the nearest 1%.

4 | RESULTS

4.1 | Mud crab value chain

There were five main players involved in the selling of mud crabs in Bua Province – fishers, traders, seafood retail shops, restaurants (independent, as well as those part of hotels and resorts), and exporters. The flow of product and activities involved from the source to the final consumer markets is shown in Figure 2. Local fishers were the primary players in the mud crab supply chain. The nearest significant business centre is Labasa in the north, where there is a sizeable consumer market, and included a small number of business hotels and local restaurants. Fishers sold directly to a variety of buyers (e.g. consumers, restaurants) or distribution channels (e.g. traders, retail shops, exporters), depending on the availability of transport (to and from their village), quality of roads, cost of travel and historic social and business links. Most fishers sold at roadsides (25%), local markets

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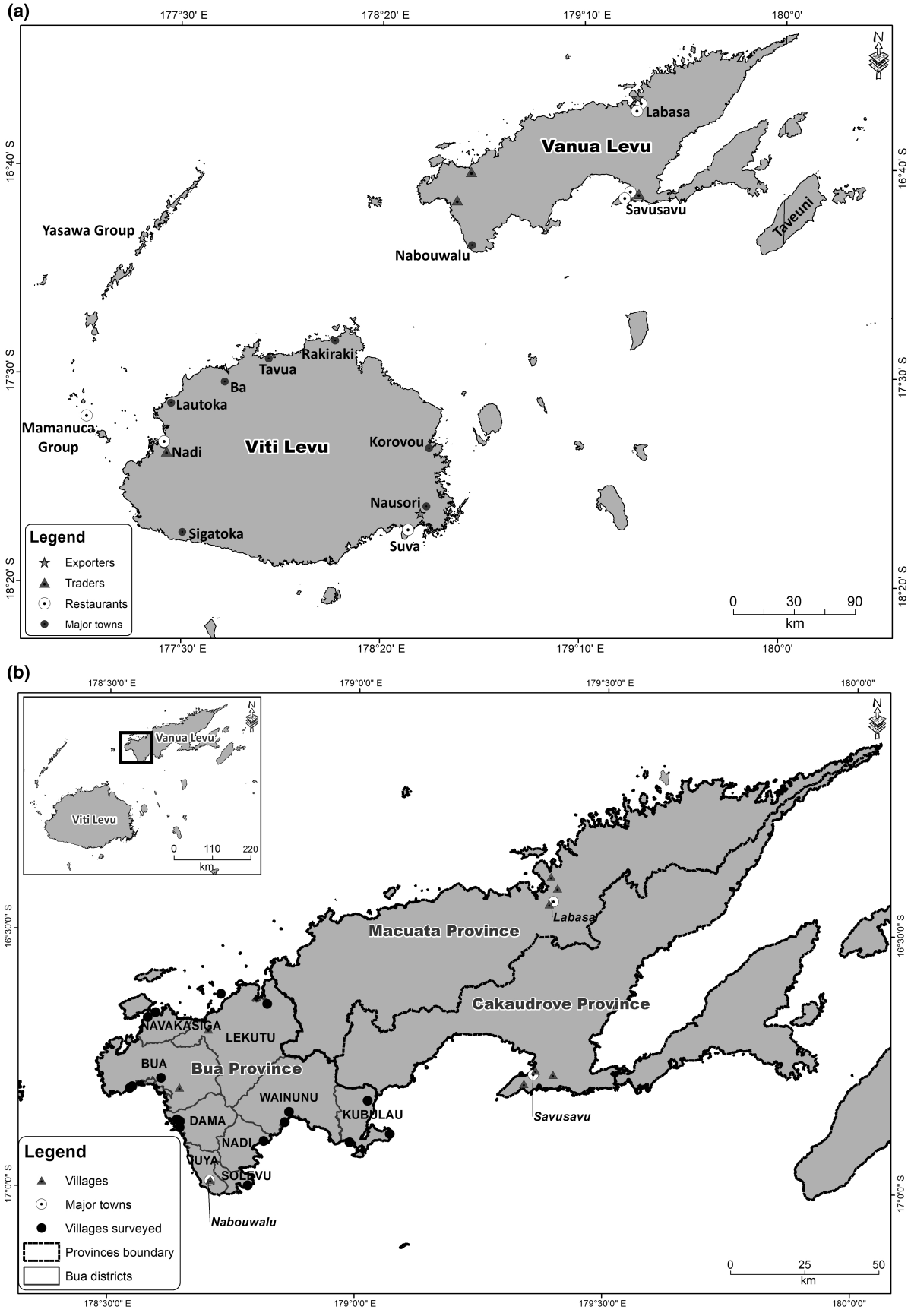

FIGURE 1 Location of villages, local markets, traders, restaurants, and exporters where value chain analysis interviews were undertaken.

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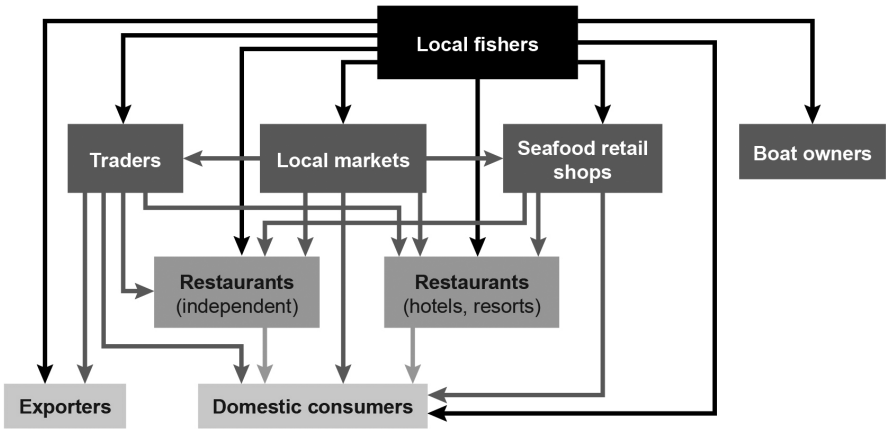

FIGURE 2 The value chain of wild caught mud crabs in Fiji.

(17%) or both (5%), or made direct sales to traders (28%), shops (27%), exporters (11%) and restaurants (<1%). Smaller players involved along the value chain were community boat drivers (all men) that provided transport for some fishers to access harvest sites. There were no players involved in post-harvest processing of mud crabs as there was a high preference for live animals along the different points of purchase.

Traders (4 women, 6 men) were largely based locally (i.e. island of Vanua Levu) operating from municipal markets in Labasa, Savusavu and Nabouwalu, or directly buying from villages in Lekutu District where they were based. However, one trader bought crabs from Vanua Levu to sell from his business in Nadi on the island of Viti Levu. All but one trader was Indo-Fijian. Traders purchased predominantly live, individual mud crabs from village fishers, other traders, or a combination of both. Traders sold to various players in the chain including household consumers (31%), other traders (31%), hotels or resorts (19%), local restaurants (13%) or retailers (6%). All fish shops sourced mud crabs directly from fishers and sold to household consumers. Three restaurants listed by traders were interviewed outside of Vanua Levu in Suva, on Mana Island (Mamanuca group) and in Nadi town. Restaurants obtained mud crabs directly from fishers or via markets (noting local fishers were often the sellers at markets); some also bought from traders.

The export market for Fijian mud crabs remains relatively underdeveloped and as a result only two male exporters operated in the mud crab supply chain from Labasa and Suva. Local fishers and traders were their main suppliers and exports were primarily to New Zealand, although an Asian market was being explored at the time of this study due to the ban on sea cucumber export (M. Fox, pers. comm.). Formal business arrangements with suppliers were rare; only two traders had formal arrangements with suppliers (described as village middlemen) and four had payment arrangements in the form of advancements to fill orders. One exporter maintained a formal arrangement with specific fishers to ensure quality and quantity of supply.

4.2 | Profile of fishers

Mud crab harvesting is predominantly done by women (88.1%) in iTaukei communities in mangrove forests and adjacent mudflats, sandflats, or seagrass beds within their customary fishing grounds. The median age of fishers was 50.5 but ranged from 24 to 75 years of age, with very few under the age of 30 (7%). Harvest sites were primarily accessed by foot, or *bilibili* (bamboo rafts), and crabs were harvested in all months of the year and mainly collected by hand (57%) or hand nets (27%). A few worked with boat drivers from their village to access more distant harvesting sites (e.g. districts of Bua, Dama, Lekutu and Navakasiga), supplying mud crabs as payment for their services. Harvesting was a social activity involving friends, family members or other members of the village with only 21% reporting harvesting alone. Most fishes preferred harvesting mud crabs during daylight hours (65%), timed to the low tide. Time investments in the fishery varied with most engaged in the fishery on a part-time basis: 60% harvested 2–3 times per week; 77% spending 1–3 h harvesting per trip; and 75% accessing sites 1 h or less away from their village.

We asked fishers to rank the main use of the mud crabs collected. Mud crabs were mainly sold (75% ranked sale to a buyer as the primary use of their catch). About 25% ranked consumption as the primary use of mud crabs (Figure 3a). Districts that were closer to or with better access to markets (i.e. Navakasiga, Bua, Dama, Lekutu and Kubulau) reported selling over 80% of their catch and consuming less than 20%; those further away or with poor access (e.g. inadequate public transport) to markets (i.e. Nadi, Solevu and Wainunu), consumed two thirds of their catch, and sold around a third.

Fishers provided mixed perceptions regarding the health of the fishery (Figure 3b,c). Overall, 46% of fishers in Bua province perceived their local mud crab population to be stable, 32% stated the numbers to have declined, and 21% the numbers to be increasing. When asked about the average size of mud crabs harvested, 57% of fishers stated there had been no change over time, while 24% felt sizes had been decreasing, and 18% reported sizes had been increasing. Perceptions of abundance and size of mud crabs were not significantly influenced by the lifestyle of harvesters (i.e. whether their primary use of catch was for subsistence or commercial purposes) and the effect of district was also not significant. When asked to identify threats to the health of the mud crab fishery respondents suggested fishing pressure caused by other villagers within their district, and in some cases outsiders (i.e. people not from their district).

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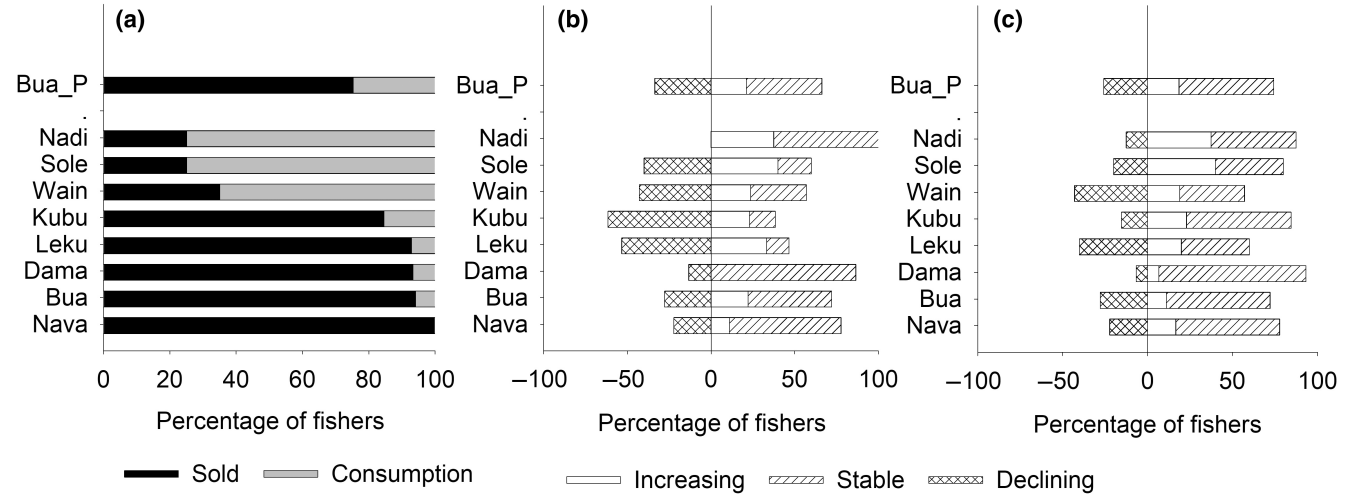

FIGURE 3 District and provincial trends in the: (a) proportion of mud crabs sold versus consumed by fisher households; (b) perceptions of fishers on trends in the abundance of mud crabs; and (c) perception of fishers on trends in the size of mud crabs. Nava = Navakasiga, Leku = Lekutu, Kubu = Kubulau, Wain = Wainunu, Sole = Solevu, Bua_P = Bua Province.

They also identified degradation of mangrove forests, increased sedimentation due to logging and soil erosion, and the use of certain harvest techniques (e.g. digging in mud crab holes, using nets, using a traditional fish poison *Derris elliptica*, known locally as *duva*, harvesting by torchlight) as additional threats.

Community management efforts were highlighted by fishers where a third of fishers described community-introduced rules – i.e., prohibition on mangrove forest harvesting or destruction, or traditional closures (*tabus*) prohibiting harvesting of marine life from mangrove areas – had been implemented to maintain the fishery; however not all fishers were aware of these rules or followed them. Only 3 of the 109 fishers interviewed knew they were not allowed to catch undersized mud crabs. When asked about current management strategies, several approaches were identified; these were primarily associated with protecting mangroves as well as preventing fishing within of near mangroves, especially with nets. However, decision-making – including the development of management strategies at the village or district level – often does not involve mud crab fishers, and only 7% (5 women, 4 men) stated they were involved in decision-making.

4.3 | Buyer preferences

The mud crab fishery reaches ethnically diverse domestic consumer groups (i.e. iTaukei, Indo-Fijians, Chinese, Rotumans, i-Kiribati), particularly in the main markets, Suva, Labasa, and Savusavu. Size and weight were consistently cited as a key criterion amongst all players (Figure 4). We found no evidence to suggest that consumer preferences differed by sex or ethnicity. Mud crabs below the legal minimum size limit (125 mm) were available for sale, and overall, only 29% of all customers interviewed could correctly state the legal size. The majority (55%) provided a size limit that was below the legal size.

Customers at the Labasa and Savusavu markets purchased live crabs individually, and paid according to weight (86%). Individual crabs were largely selected by consumers on size (17%), weight (20%) or sex (17%). We found 32% of people satisfied with the crabs purchased, while the remaining 68% raised concerns about the price and quality of crabs (Figure 4). In contrast in Suva mud crabs were sold in short (3–10 medium to large individuals) or long (10–15 small individuals) strings in addition to live individuals. Similar sized crabs were strung together, with larger ones sold separately. Customers in Suva paid US$31–35 for a string of up to 10 small-sized crabs (which were below the legal minimum size limit), US$45–61 for a string of up to 10 medium-sized crabs, and US$66 for a string of five large-sized crabs. Individual crabs were sold for US$9–12 for medium-sized crabs, and US$14–19 for large-sized crabs. Small crabs were not sold individually. Market consumers in Suva preferred to buy crabs in bundles (66%) and made their decision based on the size and price (Figure 4a). The majority of customers from Viti Levu (86%) stated they were satisfied with their purchase because they thought the prices were affordable, the crabs were of good quality, and of sufficient size and weight. Of the 14% who were not satisfied, 50% stated that this was due to high prices and low value for money. Other reasons for dissatisfaction included, that crabs were damaged, dead, undersized, or contaminated by pollution, and a few noted they wanted younger crabs.

4.4 | Earnings of value chain players

On average, fishers received the lowest prices for mud crab sales; however, there was variation in prices depending on the point of sale (i.e. sale at a market compared to sale direct to exporters) (Figure 5). Higher prices and demand occurred around Chinese New Year and Christmas, and lower demand around Diwali (Hindu festival of lights when practising Hindus become vegetarian). Fishers did

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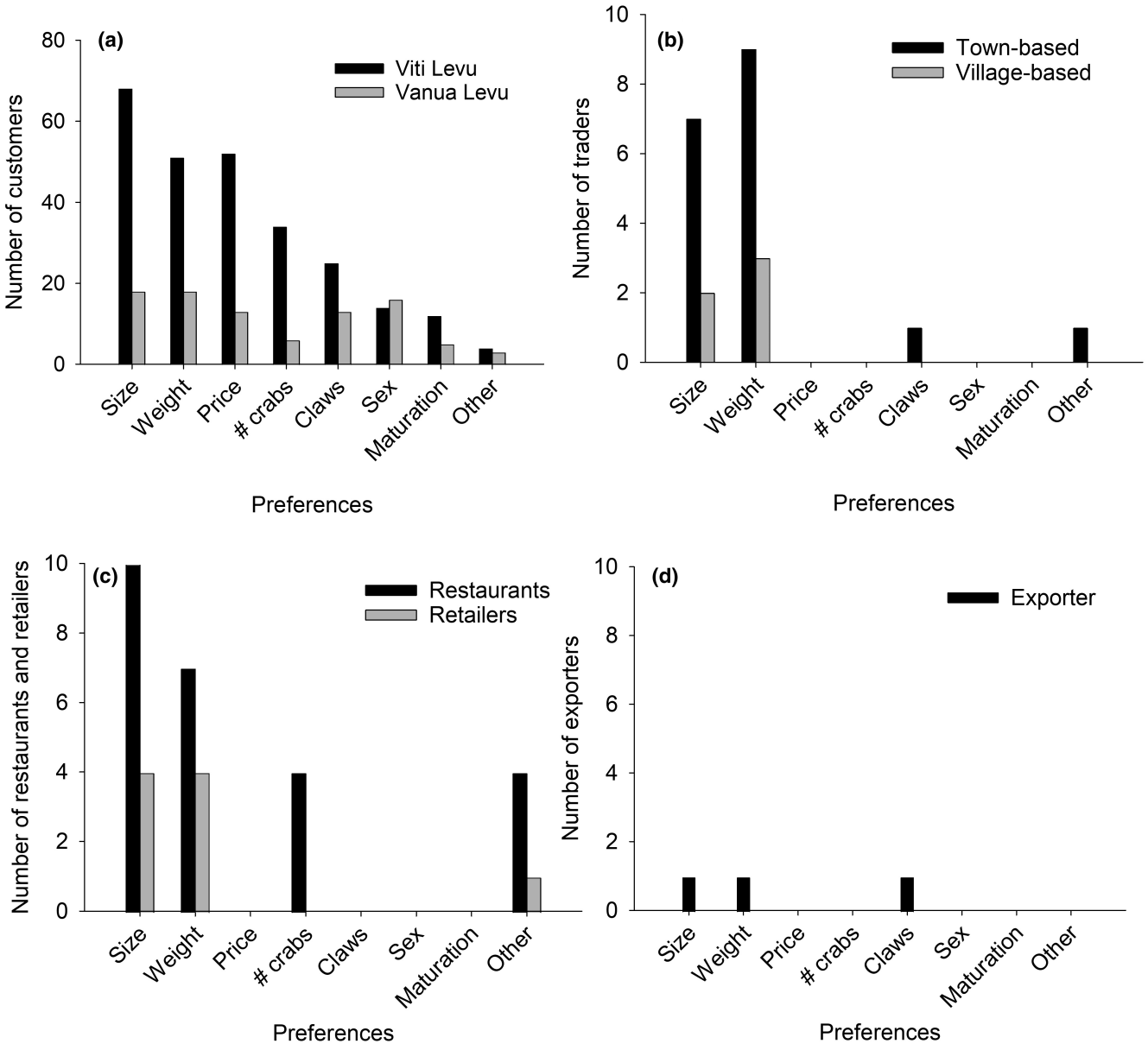

FIGURE 4 Mud crab selection preferences of (a) consumers, (b) traders, (c) restaurants (independent, hotels) and retailers, and (d) exporters. Traders and exporters often applied 'grades' as criteria for purchase (and sale): 'A' grade crabs are 1 kg and above; 'B' grade crabs are between 500 g to 1 kg. Since grades related to weight, they are included in the weight category.

not keep track of their income generated from mud crab sales, and therefore were not able to estimate how much they earned annually or between months. However, they were able to provide information on the price per kilogram, and what they earnt on their last sale. In general, fishers earned between US$3–5 per kg for medium-sized crabs, and US$5–7 per kg for large sized crabs. They estimated the average income from the last sale at the market was US$37 (but ranged widely between US$6–235) compared with an average of US$19 (with a range of US$5–94) for selling on the roadside. There was no notable difference between prices earned by women versus men (Figure 5).

While sales were more profitable where fishers were able to sell directly to restaurants or exporters, not all fishers had access, connections or relationships with large-scale traders, restaurants and exporters. Markets and roadside sale points were generally more accessible and less costly for fishers to access, with not a large price difference fetched (i.e. US$0.89 per kg more for large crabs sold at market vs. by the roadside, and US$0.60 more for medium crabs). In all cases, fishers stated they had limited power to negotiate sale prices which were determined by the buyer. However, most fishers were satisfied with the prices they received and almost all had alternative income sources (95%); only 30% listed the mud crab fishery as their main source of income.

Similarly, for traders and retailers, mud crabs were often not their primary seafood purchases (<30% of purchases) and only made up a small proportion of sales. Traders were also unable to estimate

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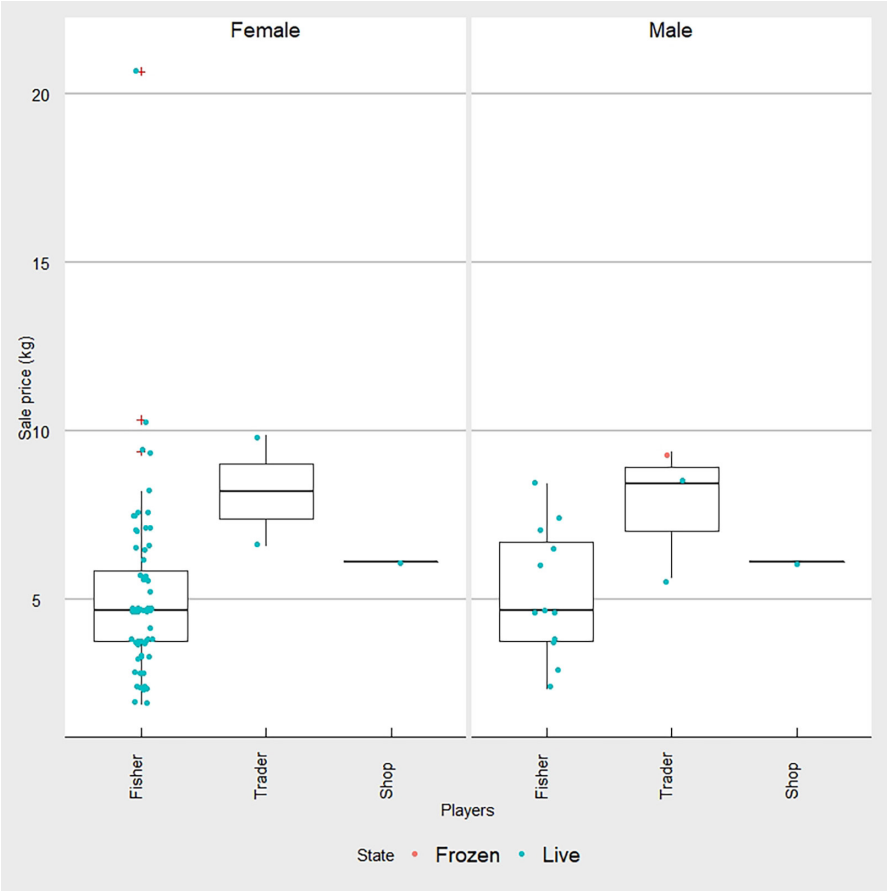

FIGURE 5 Differences in sales prices received by fishers and other value chain players to different buyers. Sale prices from fishers to restaurants was based on a single sales report. '+' represents outliers in the data.

their annual or monthly earnings from crab sales, as their income is not regular and is usually combined with the sales of other seafood products. On average traders estimated nearly US$204 on their last sale, with large variation from US$8–564. Restaurants accrued the highest average price for mud crab sales. This reflected the substantial product transformation and value-adding. All downstream players (especially traders) who purchased mud crabs for re-sale were not happy (30% were not satisfied and 20% were very dissatisfied) with the supply of mud crabs, stating they were unable to meet the market demand for crabs due to insufficient supply from fishers. For exporters the inability to meet variable market demands made the fishery (at the time of the study), unprofitable due to high air freight costs. Many players also noted seasonal fluctuations in supply over time, and four of the restaurants cited a decline in availability and quality (especially size) of crabs.

4.5 | Quality control, efficiency, and losses

Spoilage, including broken claws and dead crabs was reported amongst traders (50%) and retailers (66%). For traders, spoiled crabs were generally returned to the fisher but for retailers they were discarded as they were unsaleable to domestic consumers. Most fishers reported very few rejections from buyers and in the few instances when there were, they were generally eaten by the fisher's household suggesting there was little wastage.

A consistent theme was the need to increase and sustain a steady supply of undamaged crabs. One person suggested providing fishers with traps might improve supply. It was also postulated that establishing commercial crab farms and involvement of professional fishers might counteract supply issues. Some players gave management recommendations, including: (i) preventing capture and sale of undersized crabs; (ii) banning the harvesting of female crabs; (iii) protecting mangrove systems; (iv) greater involvement of the Ministry of Fisheries to assist in managing the fishery and to regulate licensing; and (v) improving communication and awareness of size limits throughout the chain.

5 | DISCUSSION

The mapping and analysis of the mud crab value chain provided us insights into the market drivers and challenges to productivity which underpin the sustainability of the fishery in Fiji. Although most Indigenous women fishers harvested on a part-time basis, our study found mud crabs was an important source of supplementary household income for families in Bua Province. The fishery was the main source of income for almost a third of women interviewed. We found the wild-caught mud crab value chain was characterised by low technological gear and harvesting methods, targeted largely for domestic markets or consumption and with limited value-adding activities. Despite being a lucrative

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commodity there were several bottlenecks in the fishery. The relative informality of relationships amongst players in the value chain, the independent livelihood and/or subsistence-driven harvest behaviours of fishers, and opportunistic sale of products, resulted in a fragmented supply of mud crabs. Traders targeted a range of marine species, recognising that mud crab supplies were not consistent or reliable. As a result, the fishery was not meeting the demands of a valuable domestic market.

Fragmented supply is a common constraint in the development of small-scale fisheries value chains because fishers operate individually in the production and marketing of fishery products (Jacinto & Pomeroy, 2011). In many parts of the world, including in Fiji, the fragmentation of the small-scale fisheries sector has been addressed through the setting up of fisher associations and cooperatives, where a group of fishers work together to achieve common business objectives (Ibid.). Collective action can prove beneficial in market participation by reducing transaction costs, improving bargaining power, securing necessary market information and new technologies (Basurto et al., 2013; Markelova et al., 2009; Purcell et al., 2017). There is further evidence to suggest fisher cooperatives can improve the visibility and influence of small-scale fishers in decision-making processes and management outcomes (Rivera et al., 2017) and can secure long-term business arrangements with downstream buyers (Wentink et al., 2017). For example, the establishment of the CoopeTárcoles R.L cooperative in Costa Rica, women in small-scale fisheries communities have progressively been promoted and actively engaged in administrative action and as leaders in fisheries (Rivera et al., 2017). However, the formation of collectives might be challenging and not desirable for local fishers. While cooperatives may allow for better bargaining power or increase the supply of mud crabs to meet the demand, most iTaukei fishers are hesitant because of the challenges associated with maintaining functional organisations (M. Fox, pers. comm.). iTaukei culture is hierarchical and women, especially migrant women (i.e. those who marry and move to their husband's village), have less decision-making powers than women born in the village (Gurney et al., 2021; Vunisea, 2014). Cooperatives have had a high failure rate in Fiji, especially when the idea is thrust upon people without first preparing them fully about the concepts, principles, and commitment is needed to ensure their success (Pathak & Kumar, 2008).

Limited gear requirements and demand favouring live individuals means there are few technological barriers for iTaukei fishers to enter the fishery. However, there are several barriers for iTaukei men and non-Indigenous groups to enter as fishers. Firstly, collecting mud crabs requires skills that have traditionally been passed through matrilineal lines in Indigenous communities (Kitolelei et al., 2022), and so iTaukei men (and other ethnic groups) often lack the skills needed to harvest crabs by hand and or small scoop nets. Secondly, although mangroves legally belong to the state, they are in customary fishing grounds and therefore require the permission of Indigenous villages to access the site and to collect fisheries resources, especially in Bua Province. This makes it challenging and costly for non-Indigenous fishers (e.g. Indo-Fijians brought to Fiji through a colonisation process) to access fisheries resources in mangrove forests (Mangubhai et al., 2021). Although 'good will' payments to Indigenous chiefs to access customary fishing grounds is banned, this practice continues and affects Indo-Fijians (Mangubhai et al., 2021; Nand et al., 2021). This may explain why most of Indo-Fijians interviewed were traders.

Improvements to supply require incentives for fishers to upscale harvesting, invest more time in actively engaging with the commercial industry or improve access to markets and formality in trade to encourage more consistent sale practices. However, most iTaukei women fishers who sold mud crabs preferred to harvest on a part-time basis and many were not able to access the full diversity of available markets, particularly downstream players where sales yield higher prices (e.g. restaurants). Women's ability to invest full time in the fishery is limited by the gender roles within their community, where women are primarily responsible for domestic and care work, leaving them almost half the amount of free time compared to men (Ministry of Women Children and Poverty Alleviation, 2022). This may explain why the median age of fishers was 50, as younger women have the additional responsibility of caring for young children and adjusting to living in their husband's village. The gendered-skewness in the fishery increases the vulnerability of the chain to declines in economic productivity because of its reliance on irregular suppliers, and gender-based constraints. This also means gender-sensitivity is needed when addressing supply chain sustainability (and market expansion) because the socio-economic consequences for women could be significant.

Given that increasing the harvest and supply of mud crabs is challenging for Indigenous women, there may be opportunities to increase their income through value adding. For example, customers in urban centres in Fiji are selecting mud crabs to purchase based on weight and size. Traders, exporters and retailers in particular, prefer larger and heavier crabs which yield greater price per kilogram and are considered "A" grade. Feeding mud crabs, especially those that have recently moulted can increase their weight prior to sale (Triño & Rodriguez, 2002), and the use of mud crab fattening pens in rural communities holds some promise (Giffin et al., 2019). Greater knowledge dissemination of crab fattening techniques and improved market transparency may generate greater bargaining power for women fishers. Improved access to downstream players in areas that have high tourism (e.g. Savusavu town on Vanua Levu) could also increase income.

The frequency and intensity of harvesting of mud crabs by women coupled with the use of low technology collecting methods has meant that stocks are not over-exploited in Vanua Levu (Thomas et al., 2020). However, the increasing commercialisation of the fishery and lucrative prices of mud crabs since the 1980s have contributed to a slow but steady rise in unsustainable fishing practices such as the capture and sale of undersized animals and egg-carrying females (Giffin et al., 2019; Lee et al., 2020). Lack of enforcement and limited knowledge of mud crab minimum size limits (fishers, traders and consumers) will perpetuate unsustainable practices as demand

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for mud crabs continues to grow, and threats to their habitat continues to increase (Mangubhai et al., 2019).

While local Indigenous efforts to actively manage their mud crab fishery and mangrove forests is encouraging (Giffin et al., 2019), a national management strategy is needed to manage this fishery in the long-term and address unsustainable practices. The Ministry of Fisheries drafted a national management plan for the fishery in 2018 but has since made little progress. To date, there have not been consultations with those involved in the supply chain and therefore reliant on the fishery for income. Given the dominance of iTaukei women in the fishery, it is critical they are part of decisions that affect their fishery. Although there were mixed views on the health of the fishery, women fishers did identify several threats and community management strategies offer the opportunity for local stewardship and regulation (O'Garra et al., 2023). As is the case with many fisheries, women are often overlooked in management planning, information sharing, resourcing and capacity building activities (Hauzer et al., 2013; Kleiber et al., 2015; Thomas et al., 2021). The largest mangrove forests are found on the two main islands of Viti Levu and Vanua Levu (Mangubhai et al., 2019) and consultations could strategically target these areas. Engaging women (who dominate in upstream activities), as well as other players who are invested in the fishery will ensure that they are aware of proposed management and feel responsibility towards upholding these regulations. Our study clearly highlighted players along the value chain are aware of what management measures are needed to ensure the sustainability of their fishery.

The operational costs incurred by fishers are essential to understanding investments in the fishery, as well as inefficiencies or redundancies in the value chain. However, despite having targeted questions on expenses and income, the data we collected did not allow us to estimate or make inferences about the contribution of the mud crab fishery to the wider fisheries sector. Low financial literacy in rural areas and lack of interest in keeping records, means women fishers do not track their catches or earnings, and there is insufficient data on the volumes of mud crabs being harvested and how much income the fishery generates annually for households. Limited information on catch means it is very difficult to determine the contribution the fishery makes to the national economy and like other small-scale fisheries, fails to recognise how women contribute to economic growth (FAO et al., 2023). The exclusion of women's catches in national fisheries statistics contributes to their marginalisation when it comes to decisions about mangrove forests and the fisheries resources they are dependent on (FAO et al., 2023; Thomas et al., 2021). The inclusion of women is considered critical for furthering gender equality in the fisheries sector (Lawless et al., 2022; Mangubhai & Lawless, 2021).

Finally, while this study was done in 2015, subsequent work has suggested that the roles that women play, the technology they use and their investments in the mud crab value chain do not appear to have changed (Thomas et al., 2021). This is also evident at the main local markets where women continue to dominate the fishery (S. Mangubhai & M. Fox, pers. obs.). Therefore, our paper continues to have relevancy and value for the fishery in Fiji, and for other countries wanting to examine fisheries value chains through a gender lens.

6 | CONCLUSION

By understanding the dynamics of the value chain, stakeholders can implement targeted interventions to promote fair practices and foster the long-term viability of the mud crab fishery. Moreover, such analysis facilitates the identification of potential bottlenecks or inefficiencies in the value chain, paving the way for improvements that benefit both the industry and the community it serves (FAO, 2016). Focusing on specific improvements within fisheries value chains can address broader social development outcomes such as improved income generation, poverty reduction and environmental performance (Galappaththi et al., 2021; Rosales et al., 2017).

A stable, consistent, and sustainable supply of fisheries resources is essential to pursuing market development opportunities but can be challenging with small-scale fisheries (Jacinto & Pomeroy, 2011). While mud crabs are a lucrative commodity, women's investments in the fishery were at the time of the study, and continue to be, limited by gender-based time constraints and household commitments (Thomas et al., 2021; Vitukawalu et al., 2020). At the same time these same constraints are what continue to keep the fishery (except around the capital Suva), at sustainable harvesting levels (Lee et al., 2020). Although there are barriers to other groups entering the fishery (e.g. iTaukei men, non-Indigenous groups), there is a risk that if markets expand (including international markets) this may incentivise others to enter the fishery, potentially displacing Indigenous women fishers in the future. The displacement of women from fisheries and subsequent overexploitation of species beyond sustainable levels has been documented in other parts of the world (e.g. Gardner et al., 2017), including the Pacific (Ferguson, 2021). Putting management measures in place to ensure any future commercialisation of the fishery will not become exploitative and lead to population declines, and should ensure the protection of the livelihoods of Indigenous women in Fiji.

Finally, adopting a gender lens when examining fisheries value chains is paramount for fostering sustainability, equity, and resilience within these vital ecosystems. By understanding the nuanced roles and contributions of women in fisheries, we can ensure their meaningful participation while also safeguarding against their displacement and exploitation. Integrating gender perspectives into value chain analyses not only promotes social justice but also enhances the overall effectiveness and long-term viability of fisheries management strategies. This approach facilitates the development of more inclusive policies and practices that empower all stakeholders, ultimately leading to more equitable and sustainable outcomes for both people and the environment.

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CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author, with the permission of the Wildlife Conservation Society. The data are not publicly available due to restrictions to protect the privacy of research participants.

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