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RESEARCH

Technological transformation and changing social relations in the ring seine fishery of Kerala, India

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Abstract

Across the Global South, commercial development and technological innovations are transforming fish food systems in ways that significantly impact the livelihoods of small-scale producers and the food security of the poor. A crucial but understudied aspect of such transformations is the social relations in which fish food systems are embedded. Food system transformations change power relations and rework gendered economic roles and divisions of labour in ways that often marginalise women and other vulnerable groups. In this paper, we draw on feminist studies of gender and technology and feminist commodity chain analysis to investigate the impact of technological transformation on social relations in the ring seine fishery of Kerala, India. Kerala's ring seine fishery specifically targets small pelagics like sardine, mackerel, and anchovies, which have been identified as important to the food security and nutrition of the poor. Since the mid-1980s, when the ring seine was first introduced to enable small-scale fishers to compete with mechanised trawlers, these fishing units have expanded both in terms of numbers and in size, largely as a result of locally-driven technological innovation and adaptation. Though traditional arrangements of labour deployment and wage sharing have remained, rising competition and differentiation between fishermen have ensued. At the same time, changes in processing, distribution, and trade have reworked women's economic roles and position in the fishery, and questions about long-term profitability and sustainability have necessitated interventions in governance at various levels. Tracing the trajectory of technological innovation and changing social relations through the value chain, we assessed the gendered implications of fish food system transformations for livelihoods. We found that the increase in dimensions of the new gear increased both investments and operational costs of the fishing units rendering several of them uneconomical. Time-tested social norms have also changed as competition increased, which is much more pronounced between the smaller and larger fishing vessels. The traditional wage sharing pattern still remains ensuring income security for fishermen who cannot find work as crew on these fishing vessels. Women, however, have been most affected by the changes as they no longer are able to access the fish resource as earlier for engaging in post-harvest activities, such as marketing and fish drying.

Keywords Ring seine fishery · Women · Fish food system

Introduction

Across the Global South, commercial development and technological innovations are transforming fish food systems in ways that significantly shape the livelihoods of small-scale producers and the food security of the poor (Béné et al. 2019). A crucial but understudied aspect of such transformations is the impacts on social relations in which fish food systems are embedded. Food system transformations change labour and power relations and rework gendered economic roles and divisions of labour in ways that often marginalise women and other vulnerable groups (Whitehead 1981; Babb 1982, 1989; Evans 1985; Hapke 1996, 2012; Sachs 2019; Afridi et al. 2022). Fish food system transformations can be driven by state-led development interventions to meet goals like modernizing the sector and increasing fish production (e.g., the introduction of trawlers through the Indo-Norwegian project in the state of Kerala in the early 1950s), or they may be driven by fishers

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themselves who adopt new technologies to adapt to changing economic or environmental conditions. The introduction of ring seine gear in the early 1980s in the state of Kerala, India, is an example of the latter that had and continues to have deep impacts, especially among traditional fishers (Panicker et al. 1985; Kurien 1991; Edwin & Das; 2015).

Kerala, located on the southwest coast of India, is one of the most prominent fishing states in the country. Its fisheries contribute about 13% of the total marine fish production of the country. The sector employs more than 800,000 people in capture and allied work and contributes significantly to overall growth in the Gross State Value Added (GSVA) (Government of Kerala 2022a). Kerala is also one of the top fish consuming states in India (Government of India 2020). Despite the economic importance of Kerala's marine fishing sector, fishing communities remain among the most deprived social groups in the state.

Kerala's marine fishing sector has undergone significant transformation as a result of technological change in the design and type of fishing vessels, gear, and methods of fishing (Government of Kerala 2022b). The impact of this transformation on local fishing communities, economies, and livelihoods has been profound (Kurien 1985, 1994). New technologies adopted a range of social-cultural and political economic transformations ensue (Scott 1985; Sen and Grown 1987; Hart et al. 1989). This paper investigates the impacts of technological change and economic transformation on social relations in the ring seine fishery of Kerala, India. We trace the changes in ring seine fishing units in Ernakulam District, Kerala, where ring seine gear was first introduced in 1982, and describe subsequent changes in the technology both as a result of local adaptations, institutional intervention-led changes and policy-led management measures. We discuss how the introduction of ring seines and related changes have impacted men and women's labour in the traditional fishing community that began using this technology and consider the implications for household livelihoods.

Our approach is informed by insights from feminist commodity chain analysis and feminist studies of gender, technology and development. The commodity (or value) chain perspective refers to an analytical framework focused on understanding the organizational and spatial structure and dynamics of food industries across geographic scale (see Sturgeon 2009; Hapke and Ayyankeril 2018a). Value chain analysis has emerged as an increasingly utilized approach to understand the dynamics of food systems, but explicitly gendered studies of value chains have been relatively few (Dunaway 2014a). Despite decades of research on gender and development and women's work in global production, gender questions in value chain studies have remained under-investigated until only about the past decade with the coalescence of work on gender and global commodities into the feminist commodity chain approach (see Dunaway 2014b).

Feminist commodity chain analysis (FCCA) differs from other, more mechanistic, forms of value chain analysis in the way it focuses on people rather than things. FCCA emphasizes social relations and power and understands value chains as networks of *labour* and production processes rooted in gender and racial, class, ethnic and caste inequalities (Dunaway 2014a; Collins 2014). It draws attention to diverse forms of labour and maps the ways unpaid and informal labour contribute to production at each node of the value chain, examining who does what work, how that work is remunerated or not, and the power relations underlying the conditions of that work (Pedroza-Gutiérrez and Hapke 2022). FCCA examines the way each node of a chain (e.g., production, processing, trade) is embedded in gendered relations in households and economies and asks a series of questions about both material and non-material processes that underlie the relations of production and exchange that constitute the chain and generate value (Dunaway 2001, 2014a, b). Such analyses often reveal how women's work, particularly their unpaid productive and reproductive labour, subsidize the production of commodities within value chains yet remains unrecognised and unvalued (Ferolin 2014). Following Hapke (2012) and Hapke and Ayyankeril (2018a), we centre our analysis on gender divisions of labour in fish value chains and investigate the way labour processes get reworked in the context of technological transformation.

Feminist gender and technology studies have evolved toward a theory of gender and technology that is co-constructive and dynamic (Bray 2007; Wajcman 2010; Lagesen 2012). That is, gender relations are a fundamental organizing device running through the fabric of working life (Jackson 1989). For example, the division of labour across fish value chains in Kerala is starkly gendered. Men and women have distinct and different economic roles defined by cultural norms and endowed with different levels of power, which shape how they are situated in fish economies. Technological innovation, in turn, is shaped by the social circumstances within which it takes place (Wajcman 2010: 149). What kinds of technologies are developed, how they are deployed, who has access, and so on are all informed by social-cultural contexts, including gender ideologies about work and economy. Within the fisheries sector, far more attention has been paid to the tasks that men perform than to women and their technological needs. Thus, technologies are gendered in that they are shaped by and linked to gendered divisions of labour and gender power relations. At the same time, however, technological change prompts changes in gender relations and identities (Lagesen 2012). As technological change reworks systems of economic production and exchange, the social relations of production evolve, and new forms of gender identities and relations emerge (see Hapke 2013; Hapke and Ayyankeril 2018b; Sachs 2019). The

conditions under which this happens, however, are situated and context specific. Assessing the specific ways technological change shapes fish food system transformation in different contexts is critical for understanding the gendered implications of such for livelihoods and food security. The Kerala ring seine fishery provides an ideal case to explore this issue given the importance of marine fisheries in the state as a whole, the particular technological change unfolded and continues to evolve, and the highly gendered organizational structure of the fish economy and small fish value chains.

This study was carried out in Chellanam village in Ernakulam District, Kerala which was one of the first villages to adopt new ring seine gear in the mid-1980s, and the trajectory of its transformation has been recorded here through several studies that will be discussed in the ensuing paragraphs. The traditional fishing community in Chellanam is predominantly Latin Catholic, and almost all the fisher households have a similar socio-economic background. There are about 100 fishing crafts fitted with outboard (OB) engines (hereafter referred to as OB *thanguvallams*) and 30 fishing crafts fitted with inboard (IB) engines (hereafter referred to as IB *thanguvallams*) operating in Chellanam today.

We have drawn on field research previously conducted by the first and second authors in the people and technology dimensions of the fishery respectively, supported by in-depth interviews undertaken during November–December 2021 with 10 persons (2 women and 8 men) in Chellanam village, aged between 46 and 70 years, whose livelihoods are or were directly dependent on ring seine fishing. They were all experienced within the sector, ranging from 16–50 years of engagement in fishing and fish work. We also conducted key informant interviews with the Secretary of the Chellanam Kandakadavu Fishermen Welfare Development Cooperative Society (CKFDWCS) at Chellanam village, an institution, in which the first two authors have a long standing association, and two fishermen and their wives. The Secretary, also a woman and a native of Chellanam, has 31 years of experience in the Society and has witnessed first-hand the growth of the ring seine fishery at Chellanam. Given the COVID-19 pandemic and its periodic surges, very few face-to-face interviews could be held, and the authors had to fall back on telephone interviews with the respondents in place of in-person visits.

Introduction and spread of ring seines in Kerala

Fishing in Kerala, until about the late 1960s, was mostly carried out by small artisanal fishermen with indigenous fishing craft and gear like small wooden vessels and gear made of natural twines like cotton. Traditionally, fishing communities stayed in villages close to the coast and went fishing in inshore or near-shore waters to which they had almost exclusive access rights as the sea was seen as a community asset and belonged to all of them. The catch was either sold in local markets or processed by the fisherwomen. The gender division of labour within fishing communities thus was one in which men fished (production node), and women processed the catch and took it to market (processing and trade nodes). Most of the fishermen worked as crew on board large boats owned by other comparatively well-to-do fishermen in the community, though most households generally owned small canoes that were used for very small-scale fishing, such as line fishing or gill netting. Women helped in fabricating and repairing nets at home, in addition to marketing the catch, and traditionally processed excess fish by drying and curing, which could then be sold later or consumed at home.

Fish value chains (see Fig. 1) reflected this gendered division of labour in that fish production was (and remains) performed entirely by men, and boat ownership was (and is) primarily registered in male household members' names. Women worked in home-based fish processing and in small-scale retail fish trade in which they took fish from the shore to nearby marketplaces and also sold fish door-to-door to middle and upper class houses. It is important to note that men from non-fishing communities (mainly Muslim commercial communities) also engaged in fish trade, and large-scale, wholesale, and long-distance fish trade has been dominated by men from these non-fishing communities. These male traders have also tended to dominate urban marketplaces, and women fish traders have long had to contend with male trader harassment in these spaces. The cultural implication of the home-based and small-scale nature of women's work in processing, marketing, and netmaking and repair is that it has been considered "ancillary", or secondary, to men's work in production and therefore less valued—despite its actual importance to the fish economy and fishing livelihoods. And because women's work has been considered "ancillary" to men's work, when households have financial resources, they tend to invest those in men's work in fish harvesting but not in women's work in processing or marketing (Hapke 2001b).

During the late 1950s, modern fishing vessels and gear for shrimp trawling were introduced through the Indo-Norwegian Project, which allowed vessels to go farther and deeper and expanded fishing operations and increased production (CMFRI 1969; Kurien 1991; Pillai et al. 2007; Louis et al 2019; DoF 2020). This influx of technology also brought in non-fisher investors who invested in trawlers and hired labour to carry out the actual fishing with whom they shared a percentage of the income in lieu of wages. While overall fish production increased, artisanal fishers were left out of this technology-driven change happening in marine fisheries. Their fishing vessels were small wooden plank-built or dugout canoes and gears, such as small gill nets, lines, and boat

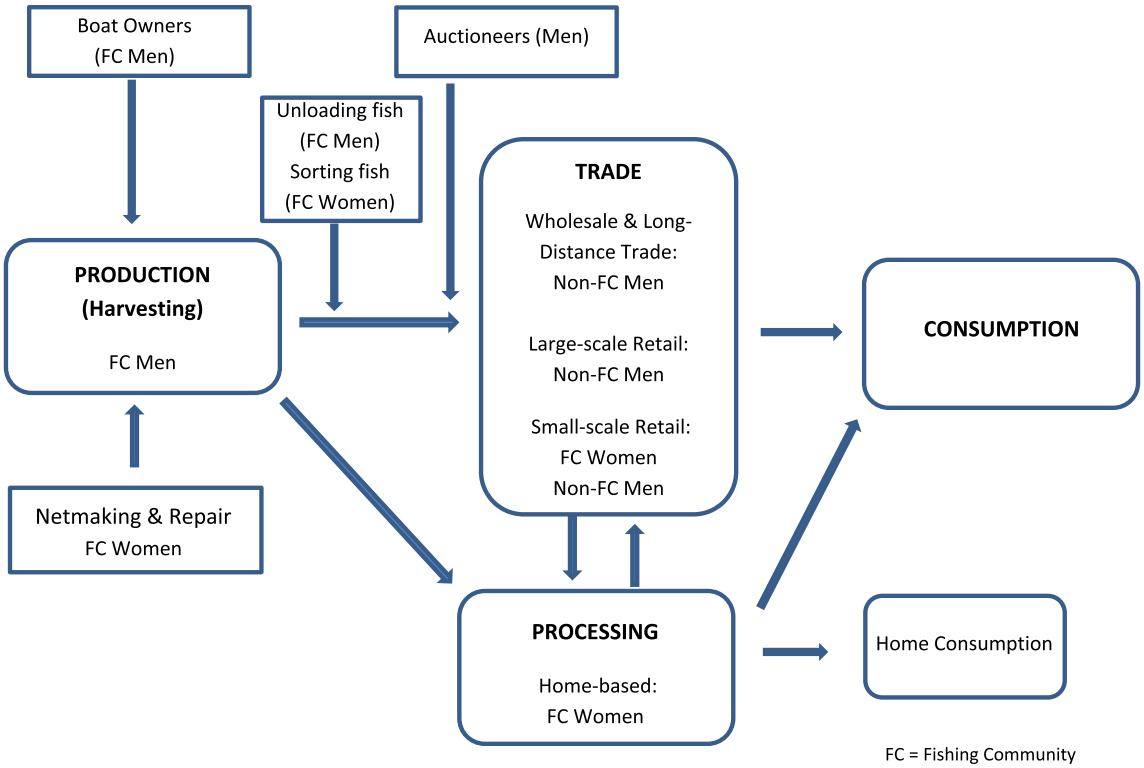

Fig. 1 The gendered fish value chain in Chellanam, Kerala, circa 1960

seines (lampara type small surface surrounding nets) that were made of natural material like cotton twines. The sea, which till then had been the preserve of the coastal fishing communities over which they had traditional access and use rights, became open access which allowed everyone with the necessary capital to enter into the field (Kurien 1991; Ruddle, 1994).

As a response to this technological and economic shift and artisanal fishermen's agitation for affordable technology, motorisation of traditional fishing vessels then began after 1982 with outboard motors introduced to fit traditional wooden vessels, an intervention which was "induced by declining productivity due to overfishing of the coastal commons" (Kurien 1991, pp. 18–19) mainly as a result of competition from the mechanised sector. Motorisation gave the traditional artisanal sector an opportunity to expand its area of fishing, and by the late 1980s, almost all traditional fishing vessels were motorised. According to the latest official data, non-motorised fishing vessels comprise only about 6.5% of total fishing vessels in the state (Government of Kerala 2015).

A significant technological change that took place in the traditional fisheries sector after motorisation was the introduction of ring seines (or mini purse seines) in the mid-1980s (http://fisheries.kerala.gov.in/). The introduction of the ring seine gear itself occurred almost simultaneously through two ways: one through community level adaptation and the other through institutional experimentation and research. The local adaptation was by fishermen who had seen a similar gear being used in on-board mechanised vessels (purse seining). The institutional intervention was carried out by the ICAR-Central Institute of Fisheries Technology (ICAR-CIFT), Cochin, where the gear was designed, fabricated, and field tested. The new gear was adopted rapidly and gave the marginalised traditional fishermen a fresh lease on life as they were able to compete effectively with the mechanised trawlers. They could now return higher volumes of catches using the new gear from their existing motorised fishing vessels. The state also recognized the introduction and spread of ring seines as a major technological change (Government of Kerala 2022c) (http://fisheries.kerala.gov.in/).

In Kerala, there already existed a cotton encircling net or boat seine called the *thanguvala* (Kuriyan et al 1962; Pillai et al. 2000) that was operated from beach landing vessels called *thanguvallams*. The ring seine can be considered a modified and innovative version of these boat seines (Das and Edwin 2018). At the time of introduction, the size of ring seine was 250 m in length and 33 m in depth and was designed for operation from the traditional plank-built or dug-out canoes of LOA (length overall) up to 9.7 m canoes (in comparison to the existing *thanguvalas* that were 42 m in length and 5.2 m in depth and were used in nearshore waters) (Panicker et al. 1985) that could be essentially operated off the existing *thanguvallams*.

The spread of the technology was rapid, and within a few years, the ring seine units had come to dominate the traditional fishing sector in the state of Kerala, especially for exploitation of small pelagics, which was reflected in the substantial increase in the landings of species like oil sardine, mackerel, and anchovies from the traditional sector. The ring seines are now a major contributor to the marine fish landings in the state of Kerala, wherein the overall landings of pelagic species dominate catches (CMFRI 2017). The contribution of ring seines has risen from 21.4% in the 1990s (Abdussamad et al. 2015) to more than 50% in the 2010s (Das & Edwin 2018). Almost 90% of the oil sardine and 60% of the mackerel landed in Kerala are now from this gear (Abdussamad et al. 2015), and important is the fact that this gear has almost completely replaced other gears that were used to exploit pelagic resources (Das & Edwin 2018; Abdussamad et al. 2015).

Subsequent spread along the Kerala coast saw a transformation in terms of dimensions of the fishing vessel and gear and in operational methods, though the basic technology design remained unchanged. The dimensions of the gear increased about four times to 1 km in length and 100 m in depth. To handle such large gears, the size of the fishing vessel also increased proportionately to about 24 m LOA, manned by up to 60 crew members. Propulsion, which was by 9.9 hp motors initially, increased to more than 600 hp, and outboard engines began to be replaced by in-board ones, which required alterations in the fishing vessel design like increase in depth, which necessitated a shift from what was until then a beach landing fishing unit, to landing in central harbours. Already by the late 1990s, several studies had documented the increased size of the gear (Edwin and Hridayanathan, 1996; D'Cruz 1998; SIFFS 1999), which continued to grow even after (Vijayan et al. 2000; Krishna et al. 2004; Edwin et al. 2010; Edwin and Das, 2015). What was significant was that these changes were mostly driven by local demands of fishermen, which led to unplanned and unsustainable expansion in the size of the fishing unit. The fishing units began to be classified into two categories, one called the motorised non-mechanical (units with out-board motor engines) and the other motorised mechanical (units with in-board engines) (Government of Kerala 2015). As per official figures, there are 206 registered motorised non-mechanical *thanguvallams* and 656 motorised mechanical *thanguvallams* in the state. Since the traditional vessels do not have enough storage space, carrier vessels or skiffs also accompanied the fishing vessel, which returned to shore with part of the catch before the main unit came back with the rest of the catch. So, in effect, a single unit has an additional vessel too. The spread incidentally was not restricted to Kerala but happened in other states as well (Rohit and Naik 1998; Mohanraj et al. 2011; Vijayakumaran and Chittibabu 2005; Shiledar 2009; Burayya 2006; Rajeswari et al. 2013; Arur et al. 2014; Bavinck 2020).

Impact of ring seine technology spread on fisher owner-producers

Technological transformations have implications that go beyond the impact on fish production. One such is on the fisher community itself. Technological adoption is driven, among other factors, by the availability of capital. Almost all of the changes that took place in the ring seine fishing unit were reflected in Chellanam village including the increase in the size of the *thanguvala* from about 250 to 1000 m, the LOA of the *thanguvallam* from about 8 to 24 m, and the engine power from about 15 to 400 hp, with the transition from the smaller OB engine vessels to the bigger IB engine powered ones that were first introduced in 1999 (Edwin et al 2010; Dhiju et al. 2012; Edwin and Das, 2015; Das and Edwin 2018).

The technology is capital intensive. On average, a steel IB *thanguvallam* and the *thanguvala* cost about INR 7.5 million (USD 100,000 approx.). The *thanguvala* alone costs about INR 1.5 million (USD 20,000 approx.). In comparison, in the early 2000s, a wooden *thanguvallam* and *thanguvala* unit would cost about INR 1.1 million (USD 15,000 approx.) (Kurup and Radhika 2003). The increase in investment is directly proportional to the increase in size of the fishing units. Increased power gave units the speed required to reach fishing grounds and return faster to the shore. This is significant because the first boat to reach a shoal catches as much as possible, and the first to return usually receives the best price of the day when the fish is auctioned (Dhiju et al. 2012; Edwin and Das, 2015). Studies have observed that the fishermen had been dissatisfied with the power and performance of the then existing fishing units as they delayed reaching the fishing ground and returning quickly to landing centres with the fish. As a result, during the 2000s, they shifted to high powered imported Chinese engines of more than 500 hp, although this brought in its wake the other issues such as lack of skilled manpower to undertake repairs and maintenance of these engines (Edwin et al 2014).

The ownership pattern of ring seine fishing units is mixed with smaller units being individually or family owned and the bigger units of more than 12 m, collectively owned by a group of about 15 fishermen, who have various levels of investment in the unit. A portion of the investment is from credit obtained from the cooperative society where they are members. The credit is advanced to the "group" and not to individual fishermen. The group gets the fishing craft and gear fabricated by local artisans in local boat building shops. For an IB *thanguvallam*, up to INR 2.0 million (USD 27,000 approx.) is advanced as credit by the society. The increased capital investment is one reason for ownership shifting to a more collective pattern (Antonyto, 2002) as this will also mean spreading and sharing the associated risks. Smaller fishing units of about 10–12 m have crews of 25–30 members

that are usually from the same extended family, unlike the bigger units that are manned by up to 60 crew members for its operation. The fishermen fishing in the IB *thanguvallams* include the shareholders as well as hired crew members.

Over the years, a sense of competition has emerged, especially when investments are made in new units. The new units became bigger than the ones previously in operation, and the investments ranged from INR 1.5 to 3.3 million (USD 20,000 to 44,000 approx.) for small and large units (Das and Edwin 2018). Over time, the increasing number and size of the fishing units have resulted in a decline in catches per unit, which has subsequently affected incomes (Abdussamad et al. 2015). Fishing itself has become unpredictable in the sense that even when shoals of fish are sighted, some boats are not able to harvest the fish. This is because, whereas previously, the first boat to *sight* a shoal had first right to harvest, now, the first boat to *reach* the fish generally is able to harvest the entire shoal before others can reach it. In earlier times, there was a sense of cooperation with fishermen informing each other of shoal sightings that could be fished by others as well. With larger nets, large shoals can now be netted in one go, and this has resulted in intra-sectoral competition, between fishers operating smaller traditional vessels, smaller ring seiners, and the larger ring seiners, though the close-knit fishing community in Chellanam are reluctant to admit this publicly.

> *Earlier the boat that sighted the shoal first was given the right to fish first, but now even if we sight, the boat that reaches the shoal first starts to encircle the shoal first and by the time we reach the fish may already be caught.*
> *Mr. J (46 years)*
> *Fisherman*

At the time of introduction of the new ring seine gear, the older fishermen had expressed reservations about the new gear, mainly about the impact on resources, which they felt would be depleted with such gear (Kurien 1991), and it is clear that a divide among artisanal fishers has happened post-1980s, between those fishers who adopted new technologies, like motorization of crafts and gears such as ring seines, and those who did not (Nayak, 2002a). It is also pertinent to note here that while violent clashes between small-scale fishermen and ring seine fishermen have been reported in other states (Bavinck 2020; Chatterjee 2022), in Kerala, these have been rare. However, the disenchantment of traditional fishers with mechanised trawl fishing is much more obvious and open (Suchitra and Venugopal 2006; John 2019), and conflict between the mechanised trawl fleet and the ring seine fleet exists. For example, state policy bans mechanised trawl boat operators from operating during the monsoon for conserving fishery resources, and these trawler operators have been demanding the ban also apply to the IB *thanguvallams*. This is a bone of contention almost every season (*Times of India*, June 18, 2002; *Deccan Chronicle*, May 11, 2018). Though various committees and fisher organisations have recommended a ban on the ring seine gear, especially during the monsoon season (Nayak and Vijayan 2006; CMFRI 2014), the official policy on the regulation of ring seine operations has been vague with a ban initially placed and subsequently revoked with the gear falling on a the list of gears that "may" be prohibited for periods as notified by the government (Government of Kerala 2022d) but in fact have not been prohibited.

The increase in size and number of ring seine fishing units has led to an increase in fish production. However, overall increased catches do not necessarily reflect higher returns as fish prices generally fall when catches are larger in the landing centres/harbours where the fish is auctioned (Gopal et al. 2000; Van der Heijden 2007; Pramod 2010; Dhiju et al. 2012).

Also, overcapacity in the sector has led to a reduction in per unit catches (Edwin and Hridayanathan 2004). This means that a few fishing units make good profits while the others do not get sufficient returns for their fishing trips. All fishing units target the same species, and in all likelihood, the fishing areas will also be the same in a particular season. Thus, it is evident that not all units are successful in their effort and come home empty-handed or with smaller catches.

Apart from uncertainties in price and production, the high operational cost of ring seine fishing units, which has increased with increasing dimensions of the units, has made fishing uneconomical. Fossil fuels, diesel and petrol, are needed for operation, and almost 60–80% of the operational costs is accounted for by this. The steady increase in fuel prices has exacerbated the situation further. Operational expenses, and often a portion of the capital investment in the fishing unit, are met from informal credit sources. Usually, the auctioneer (*tharakan*) lends this and secures the right to first sale at the harbour/landing centre. Interest rates are variable between 4 and 10%, directly affecting the value at the first point in marketing. Though this system is exploitative, it has been functioning for a long time as this ensures that fishermen get the needed funds for operating.

Besides the interest on the loan and commissions to be paid to the auctioneer, there is also an additional customary payment, called *vilikuravu*, in which a fixed percentage (usually 10%) is deducted from the auction amount by the auctioneer over and above the auction commission. This actually benefits the traders who have bid on the fish in the auction as they have to pay the fishermen 10% less than the actual auction price. Also, only the regular traders/merchants who participate in auction in a particular place get the benefit of *vilikuravu*, thus excluding new entrants (traders/merchants) into the marketing space, acting as a barrier to entry. Fishermen have no choice in the *vilikuravu* system as the practice has existed for long.

Thus, the fisherman has no control over the prices he receives at the landing centre/harbour. (Note that this is not unique to ring seine fishing units but is a universal practice in the state.) There are also costly repairs to the vessel (mainly engine) and nets which have to be undertaken by the owners. Moreover, the lack of skilled persons to repair imported engines and the laborious net repair results in loss of fishing days and income. Fishing, especially capture fishing, is fraught with uncertainties. When a fishing vessel sets forth, there is no guarantee that it will return with fish. In addition, the traditional experiences of fishermen with seasons and fish that may be available are increasingly being tested as the impacts of changes in weather and climatic conditions, including an increase in the number of extreme events experienced.

The government issues warnings and tells people not to venture out fishing. Sometimes on the days the warnings are issued, there seems to be no problem, but still they cannot go. The number of fishing days has come down from earlier times. On so many days even if they go they are not getting any catch.
Mrs. O, (56 years)
Secretary, Fishermen Cooperative Society

From the time that landings began to fall and stagnate in the early 2000s and well after that (Pillai et al. 2007; Aswathy et al. 2013), the larger ring seine units started becoming unviable, and fishermen themselves began to think about downsizing the fishing units (Edwin and Das, 2015). The larger ring seine units had gear up to 1500 length and 100 m depth, bigger fishing vessels (of up to 24.4 m), bigger crew sizes, and higher hp engines. A lack of control over the size of fishing units has resulted in a decrease in profitability, and almost 70–80% of the costs of operating larger units are attributed to fuel. All these factors led to the need for downsizing the fishing units (Edwin and Das, 2015). As early as 2012, an optimised ring seine design by ICAR-CIFT (Edwin et al. 2010) was fabricated and given for experimental operations off two fishing units in Chellanam (Edwin and Das, 2015).

The ring seine fishing boats now being constructed are a maximum of 18 m, and the gear is also proportionally smaller. Ring seine targeting sardine and mackerel has large mesh sizes of 18–20 mm and is 600–1000 m in length with a depth of 83–100 m. The ring seines targeting anchovies have smaller mesh size in the range of 8–10 mm and of 250–500 m length with a depth of 45–75 m. Currently, the average crew size of large ring seine fishing units is 45–60, while that of smaller ring seine fishing units is 25–30.

Smaller encircling nets of about 200 m that can be operated off smaller vessels of 6–7.5 m are also gaining acceptance (Edwin and Das, 2015). The earlier larger vessels are either retained for fishing during peak season, mainly monsoon, or are being disposed of while several have been sold from Chellanam, too. Studies have found that purchase of second hand ring seine units by fishermen in Tamil Nadu from Kerala exists (Bavinck 2020).

The maintenance cost and expense will be higher depending on the power of the engine. As the boat gets bigger, more labour will be required and the bata and ration to be paid also is more. The size of the boat was increased when the high-powered engines came. When the availability of fish dwindled, around 1998-2000 the boat owners decided that the length of the boat would be reduced so that the number of workers who could go fishing can also be reduced.
Mr B (56 years)
Fishing vessel owner (shareholder)

Changes in labour, income, and marketing arrangements in ring seine fishery

The labour arrangements between owners and crew members of the fishing units have remained more or less unchanged in Chellanam. An adept crew of on-board ring seine fishing units is crucial for carrying out the operations, usually under a leader called the *aaryakaaran* who is responsible for controlling fishing operations and is an expert in sighting shoals. It is under his instructions that the ring seines are released for encircling the shoal and for the subsequent activities of hauling the nets and securing the catch on-board.

A unique system of labour and income distribution exists in the ring seine fishery in Chellanam. Though the labour requirement is definite, the labour flow into the sector is dynamic, and it is customary not to deny work to any fisherman/worker who shows up for work on any given day. This is a form of disguised unemployment, as the number of workers will always be greater than the actual requirement (Dhiju et al. 2012), so even if their labour is not needed and they do not actually go on-board, they get paid a share of the proceeds from the catch. Socially, this is an important way of ensuring that income is distributed in the community.

A share system of income distribution is followed in which the income is shared between the owner(s) and crew in a 40:60 split. The income from a fishing unit that is available for distribution is after deductions for operational expenses, including fuel. Another major expense incurred is the hiring charges for vehicles that ply between the village and the harbour from where the fishing commences. This is a phenomenon that began when landings shifted from beaches near the village to the harbours on account of the larger vessels not being able to beach land. For instance, the Cochin Fisheries Harbour is about 15 km from Chellanam, and the Kalamukku harbour is about 25 km away. The fishermen have to reach the harbour very early in the morning to start the fishing trip, carefully

loading the net before they set sail. They have to thus start from home at about 3.00 a.m., and a hired vehicle is arranged to ferry them to the harbours and back to the village after the fishing trip is over.

The landed catch is auctioned in the harbours or landing centres by either auctioneers appointed by the co-operative society or by other auctioneers functioning in the harbour/landing centre. The auctioneers are also informal credit sources and so sometimes reserve the first right to auction the catches from *thanguvallams* they have lent to. After auction, about 7% of the auction amount goes to various heads like auction commission, cooperative society's share, and apex cooperative body share. A percentage is also deducted as beneficiary share, which goes to corpus that is distributed to the member fisher groups annually by the cooperative society. As mentioned above, the auctioneer customarily deducts another 10% from the auction amount (*vilikuravu*) over and above the other commissions. If credit has been advanced by the auctioneer, interest payments are also often deducted from the auctioned amount. The remaining income is available for distribution among the fishing unit owners and the crew.

The surplus labours who did not actually go on-board but had reported for work are also given an equal share of the income that the other crew members receive. This is called *karanila* (Kurien and Vijayan 1995; Berg and Lensing 2006; Dhiju et al. 2012). This category of labour is a varying number each day and can increase during the monsoon period as workers who would have worked on mechanised trawlers are jobless and may migrate to this sector in search of work. Previously, there was also another system in which fishermen get a small share of the catch in-kind to take home for household consumption. This has undergone a change with a decline in catches and is now allowed only when catch volumes are large. Only the very needy are given a share when fish catches are low.

Impact of ring seine technology spread on women's labour in processing and trade

In the years, before and early years after the first phase of motorisation, fish was landed and auctioned on beaches. The volumes were relatively small, and the value chain was relatively short for both fresh and dried fish (beach to marketplace to consumer or beach to consumer via door-to-door vending). As a result, the post-harvest economy was relatively smaller in scale than what it is today, and women played a prominent role in post-harvest activities. While motorisation increased catches, fish was still available to women to process and market because when ring seines were first introduced, they were operated from motorised, beach-landing boats. Though large-scale buyers had begun to step in when landings increased, women continued to have access to fish for drying and for marketing locally because landings took place on the beaches where their fishing villages were located. As "insiders", women could easily obtain fish on credit from fishers with whom they were acquainted if not in fact related.

Once landings shifted to distant harbours with the advent of the larger ring seine units, especially the IB *thanguvallams*, women began to get side-lined from the sector (Gopal et al. 2014). First, women's household responsibilities limit their mobility and ability to travel to distant harbours, and transport is costly and difficult to obtain. Second, in distant harbours, women are "outsiders" who need cash or connections for credit to get fish. Third, the volume of sales in harbours is larger than on beaches, which favours large-scale merchants buying in bulk. Small-scale vendors are unable to compete with cash-rich large traders in auctions so must wait to purchase smaller lots of fish from large-scale merchants at a higher price. Finally, the atmosphere is crowded and very masculine, that is, physically rough and unfriendly to women. Many women were unable or unwilling to adjust to these changes, so they dropped out of fish marketing. Other women found ways to adapt to the new market system and have continued fish market work, but the conditions of their work have changed. In contrast to men fishers who were provided transportation to harbours, women fish traders have had to make their own transportation arrangements. Groups of women hire vehicles like auto rickshaws and travel together to landing centres sharing costs among them, but they spend more time in marketing than they did earlier adding to their drudgery, as their domestic reproductive responsibilities have not reduced. And they face increased competition with men. For example, in door-to-door vending women, who are still working as headload vendors, face stiff competition from men vendors who use two wheelers like scooters or motorcycles or small trucks to reach the buyers faster than the women can on foot. During COVID, many male returnees from the Middle East with capital on hand found fish marketing a business that they could start with little difficulty further increasing competition for the fisherwomen.

Even when landings do take place from smaller boats on beaches, in Chellanam, women are hardly seen in beach-based post-harvest activities anymore. Men labourers handle unloading the catch from the boats and have taken over sorting fish and loading the baskets for further transportation. As in the harbours, women are no longer in a position to compete in auction as fishermen prefer bulk sales that reduce transaction costs and increase profits to offset increased operational costs.

With respect to processing, women historically engaged in fish drying as a small-scale, home-based activity that they controlled, and even in the early 2000s, fish drying was a major activity carried out by fisherwomen in

Chellanam. Fish was gutted, salted, and dried before being packed in small plastic packs and sold locally or in nearby markets. Women used to source fish directly from small beach landing centres in Chellanam, like Pallithode, Chappakadavu, and Chellanam, or they purchased it from other traders or vendors. The volumes were generally small, a maximum of about 10 kg. The peak season was from October to about March, which is the post-monsoon period. Women managed dried fish processing work along with their household chores, spending about 2 to 5 h daily and worked for about 175 days a year.

Since the early 2000s, however, a number of changes have taken place. First, sun drying, which was carried out on beaches, shifted to being done within the household premises or on roof tops for two reasons. One is because this coast has been susceptible to sea erosion, and the village has lost coastal beach space (KUFOS 2021), which has necessitated finding alternative areas for fish drying. Another reason is that with the population growth, the number of houses in the area has increased, heightening space constraints further.

Difficulties in marketing the dried fish due to changing consumer demand and lack of credit to expand or upgrade activity emerged as two other major constraints for continuing in this business. Added to this, as with fresh fish marketing, fish availability reduced as major landings shifted to harbours. Fish prices have increased several folds in the last 10–15 years (100–300% for the three main species caught in ring seines, sardine, mackerel, and anchovies). Women thus are no longer able to afford fish for drying, and several women have become wage labourers in others' dried fish processing yards working for INR 300–350 per day (USD 4–5 approx.). Some women have entered into arrangements with agents who supply fresh fish to their doorsteps, which the women dry for a mutually agreed wage. The agent collects the dried fish from them for further supply to wholesalers in other markets.

> *We do not have the finances to participate in the auction and must travel far to get the fish. My husband and I are drying fish for an agent. The agent gives us the fresh fish, which we dry on the beach in front of our house. He takes the dried fish, and we get INR 200 (USD 2-3) for one box of anchovies. The agent gives ten boxes every two days during the drying season. I find this convenient.*
> *Mrs. M (44 years)*
> *Fisherwoman- dried fish producer*

Over time, fisherwomen in Chellanam shifted out of fish processing work and moved on to other options like the assured employment that the rural employment guarantee scheme, MNREGA of the Union Ministry of Rural Development, offered (Government of India, 2022f). Several women also started working in other informal sectors such as househelps and in textile shops. Commercial export-oriented processing factories, which expanded in the 1990s, also absorbed some women into their labour force, though these factories now depend more on migrant labour from other states (Gopal et al. 2009). Where families are still drying fish, it is the men who now source the fish while women perform unpaid family labour, and their economic contribution thus goes unrecognised.

However, during the recent COVID-19 related lockdowns, women could not move out of their homes and so began looking for income-earning options as most other jobs became unavailable (Gopal et al. 2020). In our discussions with women, they made enquiries about cost-effective solar driers or other interventions that would enable them to engage in fish drying from home once again, as the pandemic restrictions kept family members at home, and women found themselves severely pressed for time with additional household responsibilities. That is, with schools working in online mode (Government of Kerala, 2022e), many women were not able to move out of homes for work and wanted to get back to small-scale drying activities to support household incomes, especially with the number of men's fishing days also decreasing, which had a direct impact on income of fishers and fisher households. Earlier, they could find alternative employment and so could move out of the fish sector, but during the pandemic, this became difficult, and it was convenient to rely on work they were familiar with, like fish drying, which they could do closer to their homes.

> *I used to dry fish at home before I got married. Now I work at the Fishermen Cooperative Society, but a lot of women even now are willing to take up fish drying. This is something we are familiar with and can do easily.*
> *Mrs. O (56 years)*
> *Secretary, Fishermen Cooperative Society*

Conclusion

We have seen that the introduction of ring seines as a new net for the traditional sector has had long-ranging and widespread impacts not just in fish production but also on the fishermen and women operating in the traditional sector and the various nodes of the value chain. Originally introduced as a reasonably sized net that would be easy to operate from motorised fishing boats, the unbridled increase in size and power of fishing units warranting increase in investment and high operational costs has rendered several units uneconomical. This suggests a negative effect on household debt and long-term income earning ability. The capital intensity required to invest in the new vessel and gear has led to more collective forms of boat ownership, but new forms

of competition between fishers, especially between large and small fishing vessel owners, have emerged, and social norms about who has first harvest rights have changed, to the detriment of smaller, slower boat owners. Although these conflicts appear to have been managed within the community to date, they point to subtle cultural shifts, a possibly declining moral economy (Scott 1985) with the potential for future social disruption. Fishing continues to be labour intensive and entirely male, and landings have shifted from beaches to harbours, though the income-sharing pattern and social security that *karanila* offers remain, which is a unique feature of the ring seine fishery.

The most significant impacts of this technological shift have been experienced by women working in fish processing and marketing. Two developments have worked to undermine women's access to fish to dry or sell fresh. Larger landings favour large-scale traders buying in bulk with cash, who, in the Kerala context, are most often men from non-fishing communities (see Hapke 2001a). Although women in fishing households contribute to household livelihoods through processing and marketing work and often manage their household's finances, their economic activities are considered secondary to men's work in fishing, with the effect that they have fewer financial resources at their disposal than men (Hapke 2001b). The geographic shift from local beaching landings to distant harbours has further exacerbated women's decreased ability to access fish. As noted above, fish harbours and large wholesale markets are rough, "masculine" places that many women feel reluctant to enter. Household responsibilities and cultural constraints on women's mobility through public spaces further limit their ability to travel to distant places to procure fish. Increased travel costs further cut into their earnings. While some women have found ways to cope with these shifts, many other women have either opted or been forced to withdraw from fish processing and marketing. In other cases, women have gone from running their own household-based fish drying businesses to working as wage labourers in the large drying units that have been opened by male entrepreneurs.

Though a shift toward downsizing fishing units by fishermen in Chellanam has been observed since around 2015, the marginalisation, especially of women traditionally associated with the sector, has already taken place, and no amount of re-adjustments in fishing operations is likely to reverse this, since post-harvest activities like the first sale have irrevocably shifted to areas inaccessible or difficult to access by women geographically and economically. The long-term trend stemming from this story of technological transformation is the de-feminisation of the fishery. To the extent that women have been able to find alternative employment, it is possible this has not had too deleterious effect on household livelihoods. However, as discussed above, the COVID-19 pandemic rendered some of these employment options nonviable, and further analysis of the long-term effects on household livelihoods is required.

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