



Delineating the Mud Crab Fishery and Marketing Systems: A Case Study from Coastal Andhra Pradesh, India

K.K.G. PALSAM, S. PRAKASH*, A.L. KAMBLE, N.W. QURESHI, V.K. YADAV,
J. MANISELVAM and A. THAPA

ICAR-Central Institute of Fisheries Education, Mumbai - 400 061, Maharashtra, India

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This study investigates the production and marketing of wild-caught mud crabs in Andhra Pradesh, focusing on Krishna district as a case study. Purposive and snowball sampling were used to get first-hand information from 80 mud crab fishers, 8 village collectors, and 6 large suppliers. These people were interviewed in person using a structured interview schedule. The study found that mud crab fishing was practiced by three Hindu communities, namely Yanadi, Vaddera, and Agni-Kula Kshatriya. These communities used four different gears, namely bamboo traps, crab lift nets, hooked iron rods, and gill nets, for catching mud crabs. Locals marketed mud crabs in six different grades: XL, Big, M, GL, RB, and RL. In total, six marketing channels were identified, with 65% of the total mud crab supply being export-orientated and the remaining 35% distributed across domestic markets. Marketing cost analysis indicated that local village collectors incurred an average cost of ₹16.20 kg⁻¹, while large suppliers had a higher cost of ₹36.73 kg⁻¹, mainly due to transportation, which accounted for 25.20% and 31.50% of the total marketing costs, respectively. The estimated marketing profit was ₹39.92 kg⁻¹ for local village collectors and ₹24.27 kg⁻¹ for large suppliers. Strengthening regulations, supporting fishers' livelihoods, and promoting mud crab aquaculture are crucial to ensure the long-term sustainability and resilience of the mud crab supply chain.

(Key words: Crab fishing, Grading, Marketing costs, Pricing, Scylla, Supply chain)

Mud crabs of the genus *Scylla* are commercially important edible crustaceans belonging to the family Portunidae (Mahmud and Mamun, 2013). Morphological and molecular analyses have identified four distinct *Scylla* species: *Scylla serrata*, *Scylla tranquebarica*, *Scylla olivacea*, and *Scylla paramamosain* (Keenan *et al.*, 1998). These species are distributed throughout the Indo-West Pacific region, predominantly within tropical latitudes and the temperate environments of China and Japan (MacNae, 1969). Mud crabs are euryhaline and primarily inhabit the intertidal and subtidal zones of mangrove forests and estuarine environments (Le Vay, 2001; Shelley, 2008). The demand for mud crabs is huge in both domestic and international markets (Bhuiyan *et al.*, 2021) due to their large size, delicate texture, and sweet taste (Waiho *et al.*, 2015). As a result, mud crabs fetch high prices, establishing them as one of the most valuable seafood commodities. To meet its demand, mud crabs are sourced either from wild habitats or through aquaculture.

Wild harvesting involves various capture techniques, including baited crab pots, baited traps, hooked wooden or metal rods, baited lines attached to poles, scoop nets, headlights or torches combined with scoop nets, gill or seine nets, hand-picking, and baited lift nets (Angell, 1992; Lekshmi *et al.*, 2023; Mirera *et al.*, 2013; Mohapatra *et al.*, 2011; Shelley, 2008; Walton *et al.*, 2006). Mud crabs can grow with an average biomass gain of approximately 10 g wk⁻¹, making them highly suitable for aquaculture (Paterson and Mann, 2011). The different aquaculture techniques include grow-out culture, crab fattening (Anil and Suseelan, 2001), and soft-shell crab production (Quinitio and Lwin, 2009). Despite advancements in aquaculture techniques, most mud crab aquaculture practices still rely on wild-caught juveniles due to limited commercial hatchery production, which is constrained by low survival rates and intensive management requirements. This dependency highlights the industry's continued reliance on wild mud crab fisheries.

*Corresponding author: Email: swadeshprakash@cife.edu.in

Mud crab fisheries play a crucial role in supporting coastal village economies across many tropical and subtropical regions (Mirera, 2017), providing livelihoods for small-scale fishers (Angell, 1992), traders, and transporters (Chandra, 2012). In India, mud crabs are found in the estuaries of the Ganga, Mahanadi, Krishna, Cauvery, Narmada, and Tapti rivers; the brackish water lakes of Chilka and Pulicat on the east coast; and the brackish waters of Kerala on the west coast. They are also distributed in the mangrove regions of the Andaman and Nicobar Islands, Andhra Pradesh, Tamil Nadu, and Kerala (Anil, 1997). Among the species present, *S. serrata* and *S. olivacea* are the most commonly found in Indian coastal waters (Balasubramanian *et al.*, 2016). Research on mud crabs in India has explored various aspects, including diversity (Mohanty *et al.*, 2006), reproductive biology (Viswanathan *et al.*, 2019), bioassessment (Khan *et al.*, 2018), aquaculture (Apine *et al.*, 2023; Marichamy and Rajapackiam, 2001; Shyne Anand *et al.*, 2018), food and feeding habits (Mohapatra *et al.*, 2005; Viswanathan and Raffi, 2015), fishing methods (Lekshmi *et al.*, 2023; Mohapatra *et al.*, 2011), livelihood assessments (Apine *et al.*, 2019), and

marketing (Thampi Sam Raj *et al.*, 2015). However, no study has comprehensively examined both the fishery and marketing of wild-caught mud crabs in India. In this context, the present study aims to bridge this gap by investigating various aspects related to mud crab fishery and marketing systems in the Krishna district of Andhra Pradesh.

MATERIALS AND METHODS

The study was conducted in the Krishna district of Andhra Pradesh, because of the prevalence of high mud crab fishing and marketing activities as reported by the Department of Fisheries (DoF), Andhra Pradesh. A combination of purposive and snowball sampling techniques was employed to select key stakeholders involved in mud crab marketing. Initially, purposive sampling was used to select 40 fishers from four villages, namely Jinkapalem, Gullalamoda, Sorlagondi, and Pathupkali, located in Nagayalankataluk. Additionally, 20 fishers from three villages, namely Polatitippa, Palletummalapalem, and Kona in Machilipatnam taluk, and 20 fishers from two villages, namely Interu and Pallipalem in Kruthivenutaluk, were chosen (Fig. 1). Subsequently,

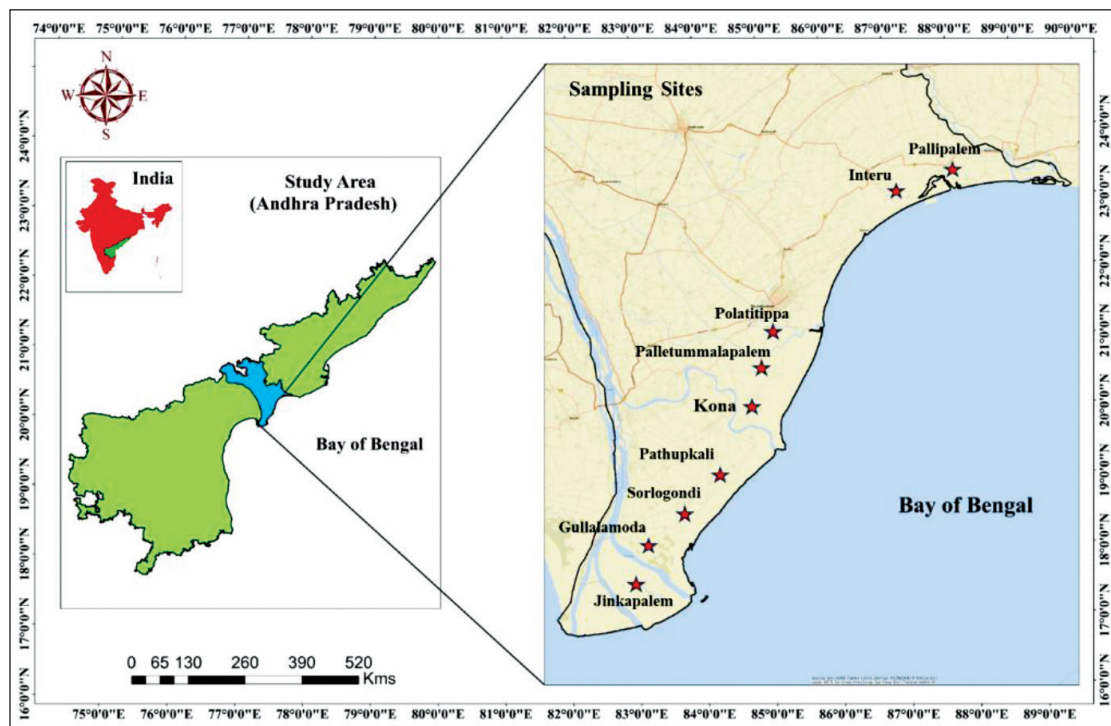


Fig. 1. Map showing selected sampling villages in the Krishna district

8 local village collectors and 6 large suppliers were identified using snowball sampling. The data for this study corresponded to the agricultural year 2022-23 and was gathered through personal interviews using a pre-tested interview schedule specifically designed for this research. The interview schedule for fishers captured quantitative data on fishing practices, including craft and gear used, fishing distance and duration, timing, catch composition, grading, sales details, and pricing structures. Meanwhile, the schedule for marketing stakeholders collected additional information on daily handling quantities (kg), pricing, and marketing costs incurred day⁻¹.

Mud crab marketing involved different grades with corresponding price variations. To determine the average purchase and selling price kg⁻¹ for various stakeholders, the weighted average method was used. This method calculates the mean value of a dataset by assigning relative weightage to each value based on its importance. In this study, the weightage was the average quantity of each grade, and the values were the respective market prices. The formula applied was:

$$\text{Weighted average} = \frac{(\text{Total of } x_1w_1 + x_2w_2 + x_3w_3 \dots + x_nw_n)}{(\text{Total of } w_1 + w_2 + w_3 \dots + w_n)} \quad (1)$$

where, $x_1, x_2, x_3, \dots, x_n$ represent the prices of different grades; and $w_1, w_2, w_3, \dots, w_n$ correspond to their respective quantities.

The study adopted the concepts of marketing margin and marketing profit based on Ahmed *et al.* (2012). The marketing margin for each functionary was calculated as the difference between the average purchase price and the average selling price, while marketing profit was determined by subtracting the marketing cost from the marketing margin. For basic data analysis, averages and percentage analyses were used. One-way ANOVA was applied to assess differences in catch quantity across fishers from the three taluks and to examine price variations for different grades among functionaries involved in mud crab marketing. Additionally, an independent t-test was conducted to analyze the differences in marketing costs incurred by functionaries involved in mud crab marketing in Krishna District.

RESULTS AND DISCUSSION

Production

Mud crab harvesting from the mangroves of Krishna district was predominantly carried out by three Hindu communities, namely Yanadi, Vaddera, and Agni-kula Kshatriya. The Vaddera and Agni-kula Kshatriya communities observed male dominance in the fishery. This aligns with findings from other studies (Manuessa *et al.*, 2024; Mirera *et al.*, 2013; Rahman *et al.*, 2020), which indicated that mud crab fisheries are typically male-dominated across various regions. However, in the Yanadi community, women actively participated in mud crab fishing alongside their partners. Locally, it is believed that the Yanadi community has specialized skills in mud crab fishing passed down through generations, making this fishery a critical livelihood source for them. Most fishers preferred mud crab fishing during low-tide periods, typically from early morning until afternoon, which is consistent with observations from Barnes *et al.* (2002) and Dumas *et al.* (2012). Regarding fishing frequency, 43.75% of fishers reported engaging in mud crab fishing six days a week, 31.25% fished five days a week, and 25% fished every day. Various fishing gears were employed, such as bamboo traps, crab lift nets, hooked iron rods, and gill nets (Table 1). The choice of gear varied across villages based on the density of mangroves and the specific skills of the fishers. Among the fishers in the study area, 56.25% used crab lift nets, followed by gill nets (18.75%), hooked iron rods (12.5%), and bamboo traps (12.5%). Fishers often combined multiple gears depending on the time, fishing competition, and their skillset. Detailed descriptions of these fishing gears for mud crabs are presented in Table 1. A locally made non-motorized boat, known as “Nava” was used to operate passive gears like crab lift nets, crab pots, and gill nets.

The crab lift net, locally referred to as “Rimmu” is a passive, circular gear with a meshed pouch at its center where bait is placed to lure mud crabs. The gear is handled using a rope extending between 2 and 12 meters. Similar crab lift nets are used in the Pulicat region of

Table 1. Specifications of different fishing gears used in mud crab fishery of Krishna mangroves

Common name	Local name	Category (Local name)	Shape of the gear	Measurements (cm)
Bamboo trap	Movva	Very small crab pot (<i>Chinna Movva</i>)	Rectangular	Length: 44 Breadth: 35 Height: 29
		Small crab pot (<i>Chinna Movva</i>)	Rectangular	Length: 50 Breadth: 40 Height: 33
		Large crab pot (<i>Pedda Movva</i>)	Rectangular	Length: 80 Breadth: 50 Height: 40
Crab lift net	Rimmu	Small crab lift net (<i>Chinna Rimmu</i>)	Circular	Diameter: 45
		Large crab lift net (<i>Pedda Rimmu</i>)	Circular	Diameter: 65
Hooked iron rod	Konku	Small hooked iron rod (<i>Chinna Konku</i>)	L-shaped	Length: 75
		Large hooked iron rod (<i>Pedda Konku</i>)	L-shaped	Length: 215
Gill net	Vala	Nil	Rectangular	Mess size: 4 (Main webbing)

Tamil Nadu (Jenish *et al.*, 2024) and in Maharashtra, where they are called circular crab traps (Lekshmi *et al.*, 2023). The bamboo trap, known locally as “*Movva*” is a rectangular passive gear, while the gill net, called “*Vala*” serves a dual purpose for catching both fish and crabs. The use of bamboo traps and gill nets for mud crab capture has also been documented in Chilika Lake of Odisha (Mohapatra *et al.*, 2011). Burrow fishing, an active method involving extracting crabs from burrows using a hooked iron rod, locally known as “*Konku*” is another prevalent technique. A similar burrow fishing method is widely practiced in various parts of the world (Bhuiyan *et al.*, 2021; Mirera *et al.*, 2013). Each community exhibited distinct preferences in their choice of fishing gear. The Vadderacomunity fishers exclusively relied on large crab pots, locally known as “*Pedda Movva*” for capturing mud crabs. In contrast, the Agni-kula Kshatriya community fishers primarily preferred crab lift nets and gill nets. Meanwhile, the Yanadi community fishers used a diverse combination of gears, with the exception of gill nets.

Grading system

In the supply chain, mud crabs were broadly classified as green and red based on their colour. This study followed the same classification and did not focus on species identification based on morphological characteristics. After harvesting, mud crabs were graded locally based on species, weight, and carapace hardness, with a uniform grading system throughout the Krishna district. Table 2 shows the details of the different grades that exist for green and red mud crabs. Green mud crabs were classified into four grades: XL (Green large) for those weighing more than 750 g, Big (Green big) for those between 500-750 g, M (Green medium) for crabs weighing 350-500 g, and GL (Green local) for those under 350 g. In contrast, red mud crabs had two grades: RB (Red big), which included females above 100 g and males above 150 g, and RL (Red local), consisting of females below 100 g and males below 150 g. Fishers reported that “RB” grade constituted the largest share of their catch among all categories, while among green

Table 2. Different grades of mud crabs by weight and their average selling price (₹ kg⁻¹) for each marketing actor in the Krishna district

Species	Locally called by	Grade name	Weight	Average Selling Price (₹ kg ⁻¹)		
				Fisher (n=80)	Local Village Collector (n=8)	Large Supplier (n=6)
Green crab	XL	Green large	>750 g	1184	1336	1440
	Big	Green big	500-750 g	856	964	1056
	M	Green medium	350-500 g	638	677	750
	GL	Green local	<350 g	268	291	358
Red crab	RB	Red big	Female: >100 g Male: >150 g	245	285	329
	RL	Red local	Female: <100 g Male: <150 g	85	102	150

mud crabs, “Big” grade was the most frequently caught, followed by M, XL, and GL. Additionally, they classified crabs with broken claws or soft shells as low-value grades, which fetch minimal prices. Exporters in Chennai and Kolkata further reclassified the crabs according to international grading standards before exporting them. These findings align with previous studies (Hossain *et al.*, 2018; Istiak, 2018; Jahan and Islam, 2016; Sultana *et al.*, 2019), which also documented the presence of domestic and international grading systems.

Catch dynamics

The average mud crab catch of fishers per fishing trip in the study area was 4.75 kg, encompassing all grades. However, a significant difference ($p < 0.01$, One-way ANOVA) in catch per trip of fishers was observed among the three taluks of Krishna district. Fishers in Nagayalanka taluk recorded the highest catch at 5.38 kg, followed by Machilipatnam (4.25 kg) and Kruthivenu (4.0 kg). This disparity was attributed to the dense mangrove forests in Nagayalanka, which required fishers to travel longer distances for fishing, resulting in higher catches. Conversely, fishers in Machilipatnam and Kruthivenu had shorter fishing durations due to the

less dense mangrove cover, leading to comparatively lower catches. Additionally, fishers reported seasonal variations in catch composition. Green mud crabs were most abundant from September to November, while red mud crabs had higher availability between November and May.

Marketing system

The marketing of mud crabs involved a complex supply chain with multiple stakeholders, including fishers, local village collectors, large suppliers, transporters, retailers, and exporters serving both domestic and export markets, as shown in Fig. 2. Six marketing channels were identified, with channels 1, 2, and 3 operating in Nagayalanka taluk and channels 4, 5, and 6 in Machilipatnam and Kruthivenu taluks. Fishers either sold their catch to local village collectors or directly to large suppliers. The presence of local village collectors was observed at the village level, where they actively purchased mud crabs from fishers and supplied them to large suppliers. To facilitate their operations, local village collectors had organized outlets, either within their homes or at separate locations, where fishers would bring their catch for sale. The role of local village

collectors was exclusively observed in Nagayalanka taluk, where they acted as key intermediaries in the mud crab supply chain (Marketing channels 1, 2, & 3). In contrast, their presence was absent in Machilipatnam and Kruthivenu taluks, where fishers directly sold their catch to large suppliers. This difference was primarily attributed to the longer distance between fishing villages and large supplier shops in Nagayalanka taluk, making local village collectors a necessary intermediary. Out of the total quantity harvested, 57% was sold to local village collectors before being fully supplied to large suppliers, while the remaining 43% was sold directly to large suppliers (Fig. 2). On average, each local village collector handled around 38 kg of mud crabs daily, with a range of 35 to 40 kg.

Mud crab marketing was predominantly managed, financed, and controlled by large suppliers, who were present at taluk headquarters and served as the central link in the entire mud crab supply chain, as shown in Fig. 2. Being licensed traders, large suppliers procured substantial quantities of mud crabs either from local village collectors in Nagayalanka taluk (Channels 1,

2, & 3) or directly from fishers in Machilipatnam and Kruthivenu taluks (Channels 4, 5, & 6). These large suppliers employed labourers to perform various tasks, like assembling mud crabs in the villages, cleaning, sorting, grading, packaging, and shop management. Depending on demand, large suppliers supplied their stock to local purchasers, exporters, or retailers. On average, large suppliers handled mud crabs around 145 kg day⁻¹, with daily quantities ranging from 100 to 250 kg.

Different marketing channels catered to distinct markets. Marketing channels 3 and 6 were export-orientated, as large suppliers supplied high-value grades (XL, Big, M, RB) to exporters in Chennai or Kolkata through train transportation. The stock was moved to the nearest railway station either by the suppliers themselves or with the help of transporters. Transporters acted as intermediaries, helping to transport the packed carts of crab baskets destined for export from large suppliers to the respective railway stations. It was noted that large suppliers from Nagayalanka and Machilipatnam taluks preferred the Vijayawada railway

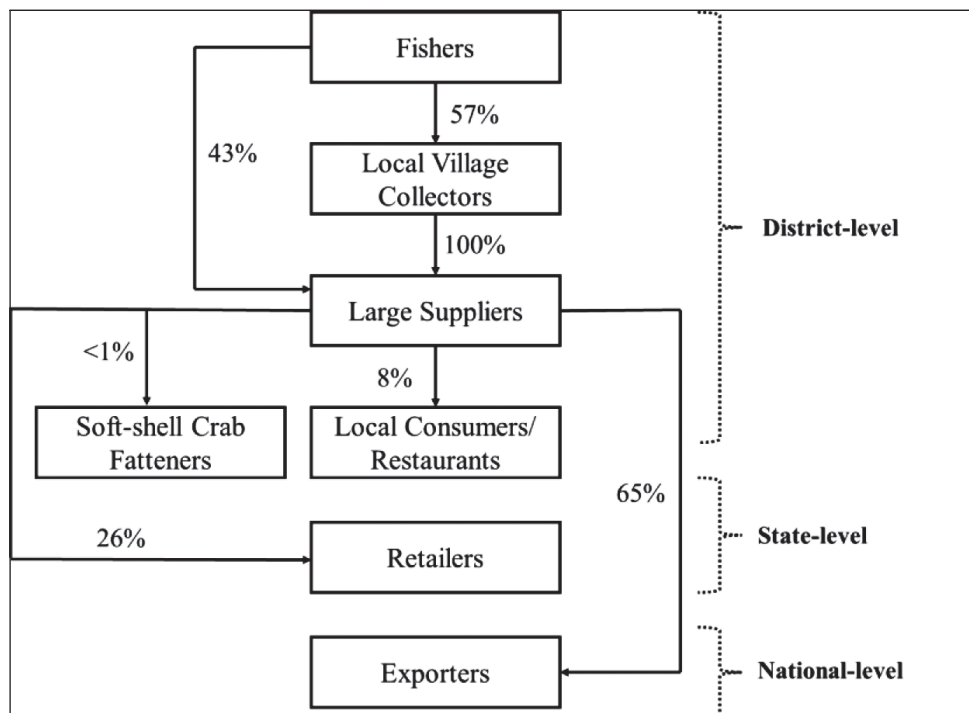


Fig. 2. Mud crab marketing system with percent of quantities supply at each stage in the Krishna district; Source: Field survey



Fig. 3. Different mud crab marketing channels in the Krishna district; Source: Field survey

station, whereas those from Kruthivenu taluk preferred the Bhimavaram railway station for transportation. Marketing channels 2 and 5 were inter-district channels, where large suppliers distributed mud crabs to retail fish markets in Gannavaram, Vijayawada, and Bhimavaram, located in adjacent districts to Krishna. Marketing channels 1 and 4 were intra-district channels catering to the demand of local consumers and restaurants within the Krishna district. It was observed that demand from local purchasers in Krishna district peaked on Sunday and Wednesday, particularly. The RB grade dominated the trade across all domestic channels (Channels 1, 2, 4, 5), with minimal demand for other grades (XL, Big, M, GL, RL). Overall, 65% of the mud crabs were supplied to export markets through marketing channels 3 and 6, whereas 26% reached retailers through channels 2 and 5, and 8% were sold to local consumers or restaurants in Krishna district through channels 1 and 4. These findings align with Jahan and Islam (2016), who also found that the majority of the mud crab catch was directed toward export, with only a small portion destined for domestic markets. During the study period, only one farmer in Nagayalanka taluk was engaged in soft-shell mud crab farming. This farmer purchased RB grade crabs, cultured them until moulting, and immediately froze and wrapped the soft-shell crabs in butter paper before sending them directly to exporters. However, this crab fattener received less than 1% of the total quantity from the large suppliers.

Pricing system

The pricing of mud crabs was largely driven by demand, with larger crabs being valued higher. The

average price received by fishers, local village collectors, and large suppliers for each of the six grades of mud crabs in Krishna district is provided in Table 2. The XL grade commanded the highest price, followed by Big, M, GL, RB, and RL grades. A significant ($p < 0.01$, One-way ANOVA) difference in price received by the actors for all the grades (XL, Big, M, GL, RL) was observed, indicating a higher price spread as the mud crabs moved from fishers to the downstream marketing stake holders. Prices also fluctuated based on availability, seasonality, and demand, with prices peaking during the season and dropping during the off-season. The mud crab market is usually active from September to May, with green mud crabs fetching the highest prices from September to January and red mud crabs from November to May. This price surge is largely attributed to the festival months (December-February) in Southeast Asian countries, during which mud crabs are considered a delicacy, resulting in a significant demand spike and driving prices to their highest levels in India.

Marketing costs

Marketing costs for mud crabs primarily depended on the volume handled and the target destination of each functionary. The total average marketing costs were ₹16.20 kg⁻¹ for local village collectors and ₹36.73 kg⁻¹ for large suppliers (Table 3). Transportation expenses accounted for the largest share of the total marketing costs, at 25.20% for local village collectors and 31.50% for large suppliers. A significant ($p < 0.05$) difference in transportation expenses was observed between the two marketing functionaries, primarily because large suppliers delivered mud crabs to more distant export

markets, resulting in higher costs compared to local village collectors. Other components of marketing costs included the cost of bamboo baskets for storage and transportation, electricity charges, packing twine, bill books, miscellaneous expenses, and costs incurred due to mortality, with no significant ($p < 0.05$) difference between the two marketing functionaries. Since the mud crabs were marketed live, packaging and transporting them in bamboo baskets allowed for free aeration, which helped prevent mortality.

It was observed that each bamboo basket was used to carry 20 kg of mud crabs. These findings align with Parvathy *et al.* (2020), who reported that bamboo baskets were used for domestic marketing of mud crabs, and Hossain *et al.* (2018) also noted that bamboo

baskets could hold between 14 to 20 kg of crabs. For large suppliers, additional costs included labour wages and shop rent and taxes, amounting to ₹3.28 kg^{-1} and ₹1.68 kg^{-1} , respectively. Fixed costs, such as the cost of articles like tables, chairs, plastic trays, and weighing machines that lose value over time, made up 0.60% and 0.20% of the total marketing cost for small village collectors and large suppliers, respectively (Table 3).

Marketing margins and profits

The average purchase price, considering all the mud crab grades handled per day, was ₹415.69 kg^{-1} for local village collectors and ₹512.58 kg^{-1} for large suppliers. The significantly higher purchase price for large suppliers was attributed to their handling of larger-sized mud crabs, which led to an increased weighted average

Table 3. Average marketing costs (₹ kg^{-1}) of mud crab marketing functionaries in Krishna district

Cost item	Local Village collector	%	Large supplier	%
Fixed costs	0.10	0.60	0.07	0.20
Rent and tax of shop	–	0.00	1.68	4.58
Wage of labour	–	0.00	3.28	8.92
Transportation	4.08	25.20	11.57	31.50
Bamboo basket	0.80	4.91	3.65	9.95
Electricity	0.19	1.16	0.17	0.46
Packing twine	1.60	9.85	1.08	2.94
Bill book	0.29	1.77	0.13	0.35
Miscellaneous	2.19	13.53	1.43	3.89
Value of mortality	6.96	42.97	13.67	37.21
Total	16.20	100.00	36.73	100.00

Table 4. Average marketing margins and profits (₹ kg^{-1}) of mud crab marketing functionaries in Krishna district

Actor	Marketing particular	Value (₹ kg^{-1})
Local village collector	Purchase price (PP)	415.69
	Marketing costs (MC)	16.20
	Sales price (SP)	471.81
	Marketing margin (MM = SP-PP)	56.12
	Marketing profit (MP = MM-MC)	39.92
Large suppliers	Purchase price (PP)	512.58
	Marketing costs (MC)	36.73
	Sales price (SP)	573.58
	Marketing margin (MM = SP-PP)	61.00
	Marketing profit (MP = MM-MC)	24.27

price. Similarly, the selling price was also notably higher for large suppliers (₹573.58 kg⁻¹) compared to local village collectors (₹471.81 kg⁻¹). The marketing margin was ₹56.12 kg⁻¹ for local village collectors and ₹61.00 kg⁻¹ for large suppliers. However, the average marketing profit was higher for local village collectors (₹39.92 kg⁻¹) than for large suppliers (₹24.27 kg⁻¹) (Table 4). Despite this, large suppliers generated higher overall revenue due to the greater volume of mud crabs they handled daily.

CONCLUSION

The high market demand for mud crab, both domestically and internationally, establishes it as a valuable seafood commodity. The industry provides livelihoods for numerous stakeholders engaged in the supply chain, extending from Krishna district in Andhra Pradesh to export markets across different states. However, years of over-harvesting to meet rising demand have led to a decline in wild mud crab populations in Krishna district. To ensure the sustainability of this industry, the government must take proactive steps to support crab fishers, enhancing their socio-economic well-being while promoting responsible production and trade. Implementing strict regulations at every stage of the supply chain is essential to prevent over-exploitation and safeguard long-term sustainability. A viable approach to mitigate the vulnerabilities of stakeholders is to encourage and expand mud crab aquaculture. Although mud crab farming was previously a common practice in Krishna district, it has been severely impacted by the sleeping disease in mud crabs caused by the Mud Crab Reovirus (MCRV). A coordinated effort involving government agencies, non-governmental organizations, industry specialists, and research institutions is crucial for reviving mud crab aquaculture to ensure the long-term sustainability of this industry.

CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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