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Research Article

Culture practices and market distribution of mud crab in Santa Teresita, Cagayan, Philippines

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Abstract

This research assessed mud crab culture practices and market distribution in Santa Teresita, Cagayan, Philippines- one of the crab culture municipalities in the province. A total of 80 mud crab key stakeholders (grow-out farmers, fatteners, dealers, retailers, and peddlers) were interviewed to gather data. The results showed that most of the mud crab farmers were male (70 %), while traders were dominantly female (97.5 %). Among the 40 mud crab farmers, 82.5 % were involved in grow-out (poly and monoculture), while 17.5 % were involved in fattening. The respondents revealed that the constraints hindering the sustainability of mud crab culture in the area included: intra-species cannibalism, flooding, limited knowledge in crab farming, and inconsistent supply of quality crab seeds. There were 6 different marketing chains identified in the area, involving different stakeholders, with Crab Farmer-Retailer-Consumer being the most common distribution pattern. The results of this research are good input for the development of a municipal mud crab management plan.

1. Introduction

Scylla spp., or mud crab, from the Portunidae family, is widely distributed, and considered as one of the key species in aquaculture (Rahman et al., 2020; Macintosh et al., 2002). The Philippines has a long history of mud crab farming, and is the world's second largest producer (Quinitio, 2017). Mud crabs are tough and can survive for lengthy periods of time out of the water at lower temperatures, making them a good species for live export to other countries (Lalramchhani et al., 2019). The three commercially important species of mud crab, *Scylla serrata, S. tranquebarica*, and *S. olivacea*, are commonly found in the Philippines, but *S. serrata* is the preferred species for farming (Quinitio, 2017).

Mud crabs are raised in pens, cages, or even simultaneously with shrimps in ponds (Chakraborty et al., 2018). As a result, shrimp producers are switching to crab farming, as it is less prone to illness, is easier to cultivate, and is more flexible to climatic change, and has a better market price than shrimp farming (Salam et al., 2012). The soaring demand and higher price in the overseas markets further aggrandized the farmer's interest in ranching crabs (Rahman et al., 2017). There are three main culture systems (crab fattening, grow-out, and soft-shell crab production) that cater to various segments of the worldwide crab market (Rahman et al., 2017). All of these farming

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systems are entirely dependent on seed supply from the wild (Salam & Ross, 2000; Rahman et al., 2018). As a result, the seed shortage has tightly restricted the expansion of crab culture (Marichamy & Rajapackiam, 2001). The lack of hatchery facility to produce crablets has been a challenge for the continuous source of seed stock and hampers the expansion of crab industry, hence the dependence on wild stocks (Ballad & Bañarez, 2019).

Marketing of mud crab is a complex system and is composed of series of intermediaries with their own unique roles in the distribution pattern, which is beneficial, especially in the market sector (Sultana et al., 2019).

Figure 1 Map showing location of study site, Santa Teresita Cagayan, Philippines.

The municipality of Santa Teresita is situated in the northeastern region of Cagayan Valley. While crablets are sourced outside of the municipality (Ballad & Bañarez, 2018), its coastal area has extensive brackish water and mangrove zones that are suitable for the culture of mud crab. However, information and documentation regarding the culture practices and marketing distribution of mud crab remains deficient; thus, this study was conducted to supplement such data. Specifically,

it aimed to: (a) determine the community engaged in mud crab culture; (b) determine the culture techniques and management practices involved in mud crab farming; (c) identify the existing market distribution pattern of mud crab in the municipality; and (d) identify problems associated with the sustainability of mud crab culture and recognize ways that could help to enhance the production, profitability, and sustainability of mud crab culture. The findings of this study will be a good input into the development of a municipal mud crab management plan.

2. Study site and methodology

Santa Teresita (**Figure 1**) is a coastal municipality in the province of Cagayan, with a land area of 166.98 square kilometers (PhilAtlas, 2021). It is politically subdivided into 13 villages and has a total population of 19,573 (Census of Population, 2020).

The primary sources of livelihood in the municipality are fishing and farming. Its extensive brackish water flows from different villages, and there is an aggregate mangrove forest area of approximately 340.1 ha. These are sporadically located in six coastal villages: Simbaluca, Centro East, Caniugan, Simpatuyo, Buyun, and Centro West. Moreover, 183.8 ha has been developed into fishponds for aquaculture (Pasion & Tumaliuan, 2015).

This study involved 40 randomly selected mud crab farmers (20 % of total crab farmer population registered in the Municipal Agricultural Office) for the assessment of culture practices. In addition, 40 mud crab traders (dealers, retailers, peddlers) with six months of trading or selling of mud crab experience were selected for the market distribution analysis.

The data were gathered from the respondents through interview using structured questionnaires. The information collected was then encoded, tabulated, and analyzed.

Table 1 Demographic condition of key stakeholders in mud crab industry.

Respondents	Frequency	Male : Female (%)	Average Age	Average Monthly Income (Php)	Average No. of Years in Activity
Grow-Out Farmers	33	70 : 30.	51	5465	**12**
Fatteners	7	71 : 29	45	7143	**5**
Dealers	7	0 : 100	49	7643	7
Retailers	14	7 : 93	43	8107	**6**
Peddlers	5	0 : 100	44	4200	**4**
Dealer/Retailers	7	0 : 100	49	8357	8
Retailer/Peddlers	7	0 : 100	42	6857	**6**

3. Results and discussion

3.1 Demographic profile and primary role of key stakeholders

Table 1 shows the demographic profile of the key stakeholders that acted as respondents. The mud crab farmers are predominantly male (69.70 %), with an average age of 51 years. The fatteners are also mostly male (71.43 %), with an average age of 45 years. The mud crab trader/dealers (100 %), peddlers (100 %), and retailers (92.86 %) are predominantly female, with an average age range of 42 to 49 years.

The results revealed that respondents who have double roles (dealer and retailer) have the highest monthly income, averaging Php 8,357.00 (1 US$ = Php 55.23), followed by solely retailers and dealers. The farmers and peddlers have the least average monthly income, which is almost 50 % lower than the dealers and retailers.

The results of the interviews revealed the roles of the key stakeholders as follows:

Crab Farmers - The crab farmers typically culture and harvest crabs in their pond or pens and then sell the collected crabs to fatteners, dealers, and retailers.

Crab Fatteners - They buy lean crab from mud crab farmers for a low price and grow it until gonad development, then sell to dealers or retailers for a premium price.

Dealers - The dealers serve as the major link between farmers and markets. They buy crabs from farmers and fatteners and sell to retailers and peddlers.

Retailers - The retailers have their space in the market. They purchase mud crab from mud crab farmers, dealers, and fatteners and sell to peddlers and consumers with minimal profit.

Peddlers - The peddlers move from the area to sell mud crab. They purchase mud crabs from dealers or retailers and sell to consumers.

Both men and women are involved in culturing of mud crab; however, men dominate the actual mud crab farming activity in the municipality, which is consistent with previous studies showing that aquaculture is a male dominated activity (Akwanyi et al., 2019). The higher percentage of men than women in aquaculture is documented and, according to the study of Arenas and Lentisco (2011), women are stereotyped as weak and cannot meet the physical demands of aquaculture. However, a small number of females are engaged in some aquaculture activities, as most earthen ponds are located near their residences. Women are able to work on crab farming activities like assisting in pond preparation before stocking, preparing and applying feed to crabs, and assisting during harvesting (washing and tying of crabs) (Pandey & Upadhayay, 2012).

On the other hand, the majority of the traders are females. The high involvement of women in the marketing or trading of mud crab is their way of contributing to their household income. Women play a significant role in the exchange of transactions and are usually more trained in terms of vending and market negotiations (Ndanga et al., 2013).

3.2 Techniques in mud crab culture

Brackish water earthen ponds, with an average size of 0.25 to 0.50 ha, are utilized for the culture operation by the 40 mud crab farmers in Santa Teresita. The majority (82.5 %) are involved in grow-out culture, while 17.5 % are involved in fattening. Grow-out is a long-term culture of mud crab wherein small crab seeds are stocked in ponds and grow to market or harvestable size, while fattening is a type of culture wherein lean crabs from ponds are held in a holding system like basket cages made of hard polyethylene material, plastic containers, and bamboo cages (Shelley, 2008). One crab is placed in each compartment and is fed to satiation with low value fish, snails, and other cheap sources of protein. The crabs are fed until the shell is hardened or up to the development of gonads (Shelley & Lovatelli, 2011).

Among the grow-out farmers, 90.90 % prefer to practice polyculture of mud crab together with other finfishes, while the rest practice monoculture. According to SEAFDEC (2016), crabs were commonly cultured together with fish in an earthen pond. Farmers preferred polyculture by stocking crabs with other finfish species such as tilapia, milkfish, siganids, mullet, and prawn. This is recommended as an alternative farming approach to avoid the production loss of farming (Shelley & Lovatelli, 2011). In addition, high profit and production has already been established in polyculture experiments of mud crab with tiger shrimp, milkfish, and mullet (Rahman et al. 2020).

Most mud crab farmers stock double-sized (2.5-3 cm) or single-sized (> 3 cm) crab seeds for stocking. Cultured mud crabs are fed with different feed types based on their availability in the local market. Almost all of the farmers fed their mud crab with trash fish, while some used commercialized feeds and other alternative feed such as snails, carabao skin (locally known as

caliente), and dried coconut meat. Low-cost trash fishes play a vital role as major feed components of protein sources in mud crab aquaculture and results in higher survival rates with better growth performance as compared to other feed types (Hasanuzzaman et al., 2014; Huq et al., 2015). Most of the farmers have 2 to 3 culture cycles yearly, ranging from 3 to 4 months. Some have limited culture cycles due to weather conditions and the unavailability of seed stocks.

The study also revealed that acclimatization, or the process of conditioning the crab seeds to a change in their new environment without causing shock that would harm them, is not commonly practiced by mud crab farmers. The majority of the crab seeds are not acclimatized and are just stocked directly into ponds. On the other hand, a few numbers of farmers acclimatize the stocks by sprinkling the crab seeds with water from the grow-out ponds for 20-30 minutes before stocking. The seeds stocked without proper acclimatization could have higher mortality rates because of abrupt changes in the new environment, especially in water temperature. Preconditioning is expected in stocking to increase temperature tolerance and extend the range of passive tolerance of the crab seeds (Rahman et al., 2020).

In addition, the majority of the mud crab farmers provide shelters like pipes, branches of trees, and other structures that can serve as shelters for mud crabs during molting. The shelters could contribute to avoiding or minimizing cannibalism during molting (Rahman et al., 2020).

3.3 Market distribution of mud crab

The market distribution describes the full range of activities from crab farmers to other actors until the commodity reaches the market**.** The study uncovered 6 chains in the distribution pattern of mud crab in the municipality:

Chain 1: Crab Farmer -> Retailer -> Consumer
Chain 2: Crab Farmer -> Dealer -> Retailer -> Consumer
Chain 3: Crab Farmer -> Fattener -> Retailer -> Consumer
Chain 4: Crab Farmer -> Fattener -> Dealer -> Retailer -> Consumer
Chain 5: Crab Farmer -> Retailer -> Peddler -> Consumer
Chain 6: Crab Farmer -> Dealer -> Peddler -> Consumer

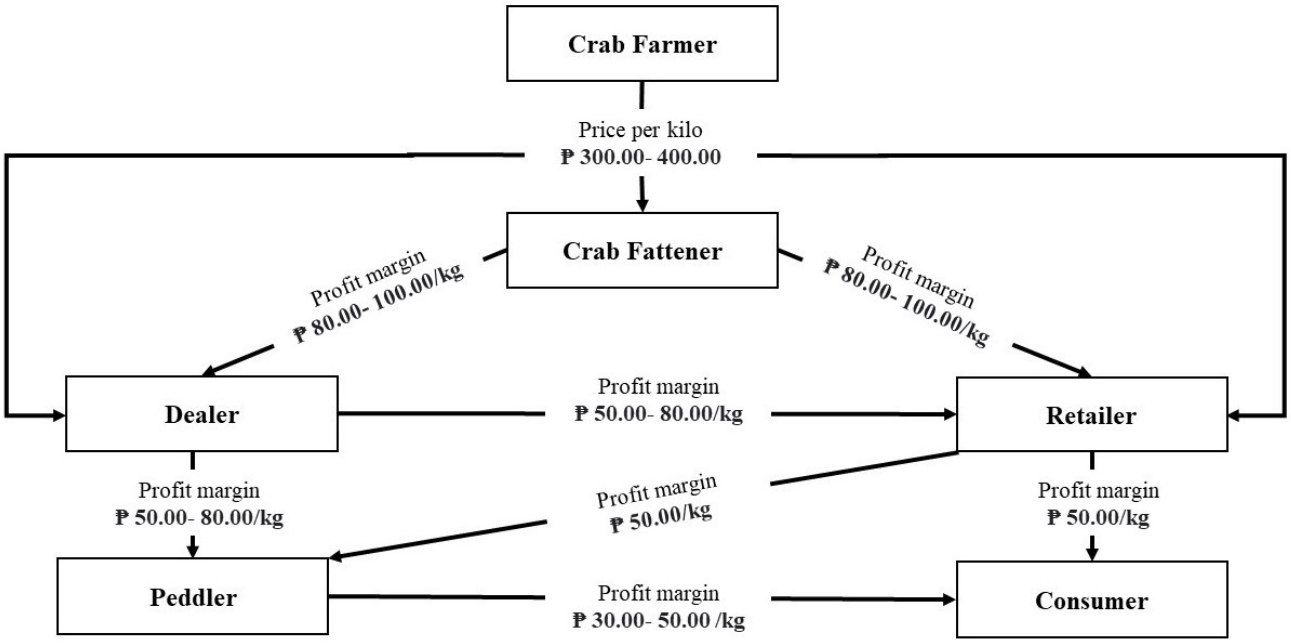

Figure 2 Farm gate price and profit gain of mud crab key stakeholders.

The farmers sell mud crab to fatteners, dealers, and retailers with a farm gate price of Php 300.00-400.00/kg (**Figure 2**). Chain 1 (Crab Farmer-Retailer-Consumer) is the most common distribution pattern in the municipality. The harvested crab is brought by the retailer from the crab farmer and is sold directly to consumers with at least Php 50.00/kg profit. In Chain 2 (Crab Farmer-Dealer-Retailer-Consumer), the crab farmer sells the crabs to the dealer who, in turn, sells it to the retailer with a Php 50.00-80.00/kg profit margin, and the retailer sells the mud crab to the consumer. Chain 3 (Crab Farmer-Fattener-Retailer-Consumer) involves the fattener, who keeps the crabs for 15-30 days and then sells it to the retailer with Php 80.00-100.00/kg profit, and the retailer to the consumer with a profit of Php 50.00/kg. Chain 4 (Crab Farmer -> Fattener -> Dealer -> Retailer -> Consumer), which is the longest structured distribution pattern, includes the dealer from Chain 3. Chain 5 (Crab Farmer -> Retailer -> Peddler -> Consumer) involves the peddler after the retailer, who then sells to the consumer with a profit of Php 30.00-50.00/kg. Lastly, Chain 6 (Crab Farmer -> Dealer -> Peddler -> Consumer) is the least occurring pattern of distribution to the municipality, wherein the dealer sells mud crab to the peddler with a profit of Php 50.00-80.00/kg, and the peddler sells to the consumer with a profit of Php 30.00-50.00/kg. The peddlers are small-time businesspersons with limited capital. Peripheral practices like peddling are typically less profitable and are often done by those who cannot afford the costs of more profitable activities (Manlosa et al., 2020).

Only live mud crabs are transported and sold to markets. live crabs are maintained by spraying brackish water on them. Live mud crabs are delivered to the local communities by motorboats, single motors, tricycles, or vans. Banana or betel-nut leaves are occasionally placed at the bottom of containers to keep moisture and keep the temperature low. This study also revealed that most of the key actors consider the body size and body weight, followed by the intactness of the limbs, when purchasing mud crab.

3.4 Size classification and pricing of mud crab

Table 2 shows the price of mud crab in the area based on grade or weight. Mud crabs weighing more than 200 grams are considered as of marketable size and are graded as small, while mud crabs weighing more than 350 grams are graded as medium, and those weighing more than 500 grams are graded as large. Increase in the price of mud crab occurs during peak season such as holidays and local celebrations (Gaillard, 2010). Mud crab prices vary with markets, seasons, and supply and demand (Baliao et al., 1999).

Table 2 Grading of mud crab along market distribution.

Grade	Weight (g)	Price Range/ kg (Php)	
		(Off-Season)	(Peak Season)
Large	> 500	500	800
Medium	> 350	350	450
Small	> 200	250	300

3.5 Constraints in sustainable mud crab culture

Table 3 shows the major problems in mud crab culture, as identified by the respondents.

Table 3 Problems encountered by mud crab farmers.

Problems	% of respondents who encounter the problem
1. Intra-species cannibalism during molting period.	98
2. Flooding caused by long duration of rainfall.	93
3. Limited professional knowledge of mud crab farming.	86
4. Inconsistent supply of good quality crab seeds.	80

The most common problems faced by the farmers are intra-species cannibalism, which results in reduced population and production of mud crabs. Molting is the shedding of the exoskeleton (cuticle) of the previous life stage. During the molting process, the new shell is very soft at first, making the crab vulnerable to predators. The mortality of mud crabs during the grow-out phase has been largely attributed to cannibalism, which affects survival and appears to be partly dependent on stocking density (Trino et al., 1999). The use of crab shelters increases survival by minimizing agonistic encounters between crabs. It is required to stock uniform sizes of crab seed, to provide adequate food supply, and to provide enough shelters or hiding spots to minimize or avoid cannibalism (Quinitio, 2005).

Flooding is also one of the major constraints in mud crab culture. The area frequently experiences heavy rain and flooding, which contribute to unstable water salinity. Flood mitigation is very much needed to address this all-encompassing problem. Proper layout and installation of structures is needed to maintain the required depth for the culture of species (SEFDEC, 2016).

Limited professional knowledge on mud crab farming was also identified as a constraint in mud crab production. It was noted that some of the farmers refuse to attend seminars and opt to rely on their first-hand experiences in the culturing of mud crab. Provision of training and rendering technical assistance to mud crab farmers, as well as the provision of access to information about technology improvements in mud crab farming technologies, could be a great help in equipping the farmers with knowledge. Training programs raise the skills and knowledge of farmers in order to be confident and successful, and eventually lead to increased productivity and income (Quinitio & Estepa, 2017).

Inconsistent supply of good quality crab seeds was also pointed out as a constraint. This is due to the uncontrolled exploitation of wild crab stocks and inadequate wild production to support increasing demand for mud crab culture in the municipality. The demand for mud crab increases annually, and the negative impact on the wild population is increasing, since most mud crab landings still rely heavily on captured fisheries (Gaillard, 2010). As a response to this issue, the establishment of mud crab hatchery is needed in the municipality. Development of mud crab hatchery technology is desirable to improve the consistency of seed supply (Quinitio, 2015). As this will provide a steady supply of seeds, it will also decrease dependence on wild supply, thus ensuring the sustainability of the natural stocks.

4. Conclusions

Mud crab culture and marketing activities contribute to the economic well-being of both men and women in the locality. Different techniques and strategies for rearing mud crabs are employed by farmers in their ponds, but the activity is being challenged by various constraints. Interventions such as establishment of hatcheries and the provision of training and technical assistance, among others, are necessary to address the identified limitations. Six different marketing chains have been identified in the area, involving different stakeholders, with Crab Farmer-Retailer-Consumer being the most common distribution pattern. In-depth understanding of the issues and concerns under each chain should be looked into as an additional input to the information gathered.

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