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Production Economics and Marketing of Mud Crabs in the Philippines

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Abstract

The current price of mud crabs in the local market is relatively higher than fish and mollusks and is projected to increase in the world market. This increasing trend in domestic and export markets is expected to step-up the demand for crab seeds. In the Philippines, the technology of mud crab grow-out culture is already being transferred to resource-poor fisherfolks for adoption as an alternative livelihood. However, buying competition among big and small crab farmers is foreseen to be disadvantageous to small farmers. There is a need to hasten the development and transfer of technology on mud crab breeding and hatchery to stabilize the supply and price of crab seeds. This paper discusses the economic viability of four grow-out culture methods for mud crabs namely; pond monoculture, polyculture with milkfish, culture in mangroves, and fattening in ponds. The marketing system of mud crabs covers product development, pricing, distribution channels, and promotion activities.

Introduction

The Philippines is one of the biggest producers of mud crabs or mangrove crab (*Scylla serrata*) in the Indo-pacific region. In 1992 to 1996, however, mud crab production decreased from 7,632 mt in 1992 to 3,876 mt in 1996 (BFAR 1997). In monoculture or polyculture with milkfish or shrimp, mud crabs fetch high prices from both domestic and international markets (Agbayani et al. 1997).

The development and transfer of mangrove-friendly mud crab culture technology are being undertaken by research institutions such as the Southeast Asian Fisheries Development Center, Aquaculture Department (SEAFDEC/AQD) based in Tigbauan, Iloilo, Philippines. This technology transfer is intended to supplement the income of resource-poor fisherfolk. Through this initiative, it is expected that the fisherfolk will now be more cooperative in the conservation of the mangroves, which are considered as nursery grounds of mud crabs.

Many countries in Asia and Europe have high crab consumption growth rates and total consumption figures. China, USA, Japan, Korea, and Thailand (Breinl and Miles 1994) ranked as the top five biggest consumers of crabs and Singapore is not far behind. In the Philippines, there is a deficit in the supply of crabs for the export market. An increasing demand of crabs globally will also mean an increasing demand for crab seeds.

The objective of this study is to analyze the economic viability of the four culture systems of mud crabs namely; monoculture, polyculture with milkfish in ponds, culture in mangroves, and fattening. The marketing system of mud crabs is also described in terms of product development, pricing considerations, distribution channels, and promotion activities.

Materials and Methods

Technical aspects

The parameters (Table 1) used in the economic analysis were based on results of research by SEAFDEC/AQD on growing mud crabs in ponds in monoculture (Baliao et al. 1981; Agbayani et al. 1990), in polyculture with milkfish (Lijauco et al. 1981), in mangrove mud crab culture (Triño et al. 1999; Baliao et al. 1999) and crab fattening in ponds (Samonte and Agbayani 1990). Stocking densities were uniform at 5000 m^{-2} in the first three culture systems and 200 m^{-2} for crab fattening. Culture periods ranged from 20 days (crab fattening) to 150 days (culture in mangroves). The monoculture method took only 90 days, making possible three crops per year compared to polyculture with milkfish (140 days) and mud crab culture in mangroves (150 days) where there can only be two crops per year. Final weight was heaviest (507 g) in fattening since initial stocking weight was already high at 165 g.

Economic analysis

Standard production economics in computing cost and returns and discounted cash flows were performed (Shang 1990). Sensitivity analysis was also done to determine the levels of risk caused by a 20% decrease in market prices of mud crabs and a 30% decrease in farm production.

Results and Discussion

Economic analysis

The 1999 prices of inputs and outputs were used in the economic analysis. In terms of investments per hectare (Table 2), capital outlay for pond system and mangrove system were PhP31,565 and PhP30,185 respectively. The mangrove system had the highest working capital because of longer

culture periods and higher feed costs while the fattening method had the lowest costs because of a shorter culture period. Thus, total investment was highest in the mud crab culture in mangrove (PhP14,998) and lowest in the fattening method (PhP44,038) based on 1999 prices (Table 2).

In the comparative costs and returns of the four mud crab culture methods (Table 3), the monoculture system registered the highest revenue per year (PhP764,250) due to the higher production of 1,019 kg·crop^{-1} (3,057 kg·year^{-1}). In the polyculture method, only 500 kg/crop (1,000 kg·year^{-1}) of mud crab and 373 kg·crop^{-1} (746 kg·year^{-1}) of milkfish were produced

Table 1. Technical information on various culture systems

	Monoculture[1]	Polyculture with milkfish[2]	Mud crab culture in mangroves[3]	Fattening[4]
Stocking density ha^{-1}	5000	5000	5000	200
Days of culture/run	90	140	150	20
Number of runs/year	3	2	2	8
Initial weight of crabs/pc (g)	25.3	36.1	16	165
Average body weight (g)	231.6	191.3	300	507

[1] Baliao et al, 1981; Agbayani et. al 1990
[2]Lijauco et al. 1981
[3]Trino et al. 1999 ; Baliao et al. 1999
[4]Samonte and Agbayani 1990

Table 2. Investment requirements on a per hectare basis

Items	Pond systems			Mud crab culture in mangroves		
	Quantity	Unit cost (PhP)	Total cost (PhP)	Quantity	Unit cost (PhP)	Total cost (PhP)
A. Capital outlay						
Pond improvements						
Bamboo poles	150	50	7,500	210	50	10,500
Green nylon net	402	18	7,236	402	18	7,236
Fine mesh nylon screen	448	3	1,210	448	3	1,210
Polyethylene rope	14	23	320	14	23	320
Nylon monofilament	17	120	2,040	14	190	2,660
Nails	4	40	160	4	40	160
Plastic sheet (rolls)	1	4,000	4,000	1	4,000	4,000
Construction of mounds	100	50	5,000			
Tools and other paraphernalia			2,000			2,000
Labor for fence installation	15	140	2,100	15	140	2,100
Subtotal			31,566			30,186
B. Working capital*						
Monoculture			98,878			
Polyculture with milkfish			100,700			
Fattening			12,472			
Crab culture in mangroves						118,812
C. Total investments						
Monoculture			130,444			
Polyculture with milkfish			132,266			
Fattening			440,375			
Crab culture in mangroves						1,498,998

1 US$ = 39.05 Philippine Peso (PhP)

amounting to a total revenue of PhP287,300. The revenue in the mangrove method was PhP444,250 from a production of 888.5 kg·crop^{-1} or 1,777 kg·year^{-1}. The crab fattening method registered the lowest revenue of only PhP179,520 because of the low stocking rates. Selling price for all methods was pegged at PhP250·kg^{-1}.

Variable cost per crop was highest in the mangrove method (PhP118,812) compared to monoculture (PhP98,878) and polyculture with milkfish methods (PhP100,700). This is primarily due to the lower feed conversion ratio of 3.5:1 for the mangrove system compared to monoculture (1.78:1) and polyculture methods (3:1). Variable cost was lowest at PhP12,472 in the fattening method. Unit costs of crab juveniles, chicken manure, trash fish, and labor were pegged at the same prices for all culture systems. Caretaker's salary was also priced at PhP6,000 year^{-1} for all systems. Loans were computed at 50% of total investment. Amounts of loans were PhP65,222 for monoculture, PhP66,133 for polyculture, PhP74,499 for the mangrove and PhP22,019 for the fattening method. Interest expenses were computed at 12% per year payable in three years. Annual repayments were computed at PhP27,393 for monoculture, PhP27,775 for polyculture, PhP31,289 for the mangrove system, and PhP9,248 for the fattening method.

The monoculture method yielded the highest net income at PhP438,004 while polyculture with milkfish and the fattening method had the lowest.

Farm gate prices of mud crabs were pegged at PhP250 kg^{-1} during the entire three years, whereas, input prices were assumed to increase at 10% per annum (Table 4). Net cash flows for three years were high and sufficient to pay the annual loan amortization for all the culture systems except for the polyculture with milkfish where a negative value was registered on the third year. This is due to the conservative estimate that output prices will remain constant for three years. In reality, however, market prices for fishery products have been increasing during the past years due to dwindling supply from the wild.

The economic indicators for all systems were encouraging (Table 5). The best economic indicators were posted using the monoculture method. Production cost of using this method was lowest at PhP107 kg^{-1} and highest in the polyculture method at PhP221 kg^{-1}. Return on investments (ROI) was also highest in the monoculture method (280%) and lowest but still acceptable at 37% for the polyculture method. Net present values (NPV) and internal rates of return (IRR) were high in all culture methods. IRR ranged from 185% for the polyculture method to 1430% for the monoculture method. Mangrove-friendly mud crab culture posted high economic returns in both short-term (ROI) and long-term (NPV and IRR). Based on these findings, mud crab culture in mangroves is a good alternative livelihood for small-scale fishers. Through this, they may also be encouraged to conserve the mangroves that serve as the nursery grounds of mud crabs.

Based on the sensitivity analysis (Table 6), the monoculture method and the mud crabs in mangrove system showed acceptable economic indicators (35

Table 3. Cost and returns of different culture systems for mud crab

Items	Monoculture system			Polyculture with milkfish			Mud crab culture in mangroves			Crab fattening		
	Quantity (kg)	Unit cost (PhP)	Total cost (PhP)	Quantity (kg)	Unit cost (PhP)	Total cost (PhP)	Quantity (kg)	Unit cost (PhP)	Total cost (PhP)	Quantity (kg)	Unit cost (PhP)	Total cost (PhP)
Revenue												
Crabs per crop	1019	250	254750	500	250	125000	888.5	250	222125	89.76	250	22440
Per year			764250			250000			444250			179520
Milkfish per crop						18650						
Per year				373	50	37300						
Total revenue			764250			287300			444250			179520
Variable costs												
Chicken manure	1000	1.2	1200	1000	1.2	1200	1000	1.2	1200			
Crab juveniles	5000	12	60000	5000	12	60000	5000	12	60000	198.56	30	5956.8
Milkfish juveniles				2500	2	5000						
Trash fish	1753		21036	1500	12	18000	3180.83	12	38169.96	160	12	1920
Labor (man days)	90		9000	140	100	14000	150	100	15000	20	140	2800
Marketing expenses-1%			7642.5			2500			4442.5			1795.2
Subtotal/crop			98878.5			100700			118812.5			12472
Total/year			296635.5			201400			237624.9			99776
Fixed costs												
Interest expense			7827			7936			9123			2642
Depreciation			15782.75			15782.75			15092.5			15782.75
Caretakers salary			6000			6000			6000			6000
Subtotal			19609.75			29718.75			30215.5			24424.75
Total costs			326245.3			231118.8			267840.4			124200.8
Net income before tax			438004.8			56181.25			176409.6			55319.25

1 US$ = 39.05 Philippine Peso (PhP)

Table 4. Three-year cash flow projections of various culture systems

	Monoculture system Year				Polyculture with milkfish Year				Mud crab culture in mangroves Year				Crab fattening Year			
Items	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
Revenue		764250	764250	764250		287300	287300	287300		444240	444240	444250		179520		
Capital outlay	31566			41035.8	31566			41035.8	30185				14267		179520	179520
Operating expenses																
Chicken manure		1200	1320	1452		1200	1320	1452		1200	1320	1452				
Crab juveniles		6000	66000	72600		60000	66000	72600		60000	66000	72600		5957	6552.7	7207.97
Milkfish juveniles						5000	5500	6050								
Trash fish		21036	23139.6	25453.56		18000	19800	21780		38170	41987	46185.7		1920	2112	2323.2
Labor		9000	9900	10890		14000	15400	16940		15000	16500	18150		2800	3080	3388
Marketing expense		7642	8406.2	9246.82		2500	2750	3025		4443	4887.3	5376.03		1795	1974.5	2171.95
Caretakers salary		6000	6600	7260		6000	6600	7260		6000	6600	7260		6000	6600	7260
Interest expense		7827	5479	2849		7936	5555	2889		9123	6386	3321		2642	1849	962
Subtotal		310461	338376.4	369036.1		215336	233695	253843		252749	274374.6	298108.5		108418	118202.6	128951
Total	31566	310461	338376.4	410071.9	31566	215336	233695	294878.8	30185	252749	278023.9	305826.3		108418	118202.6	128951
Net cash flow	-31566	453789	425873.6	354178.1	-31566	71964	71964	-7578.8	-30185	191491	210640.1	231704.1	-14267	71102	61317.4	50569.04

to 138% ROI and 171 to 696% IRR) even if production decreased by 30%. The other systems had low and negative returns. When prices decreased by 20%, all systems except the polyculture with milkfish registered acceptable economic returns ranging from 47 to 185% ROI and from 214 to 942% IRR.

Marketing systems of crab

The four "Ps" namely product, price, place, and promotion are the essential factors in the marketing "mix" (Kotler 1980) of crabs (Fig. 1). Crab consumers prefer live and hard-shelled crabs of at least 200 g. Males are chosen for the meat and larger claws while the females are bought for their "eggs" or ripe ovaries (Overton and Macintosh 1997). It is an exotic food usually served at private parties and in specialized seafood restaurants.

A recent product innovation on mud crab culture is the soft-shelled crab (Overton and Macintosh 1997). These are harvested immediately after molting, chilled and frozen for export in the same manner as shrimps. To sustain this type of crab farming, a substantial number of small crabs that molt faster are required for stocking. This market is still small and will require market development.

Prices of mud crabs in the Philippines are generally higher than fish and mollusks and are about the same as shrimps. Currently, ex-farm average price is about PhP250 kg^{-1} (US$1.00 = PhP39.05), with the females priced about 10% higher. Due to its high price, Filipino consumers are

Table 5. Summary of economic indicators of various systems

Items	Monoculture	Polyculture	In mangroves	Fattening
Total investments	130443	132265	148997	44037
Net income	438005	56181	176410	55319
Production cost/kg	107	221	151	173
Return on investment	280%	37%	99%	121%
Payback period (yr)	0.35	2.1	1	0.64%
Break-even quantity (k)	572	552	736	83
Break-even price (P)	140	276	207	231
Net present value	908208	65876	432,231	126,400
Internal rate of return	1431%	185%	622%	483%

Table 6. Sensitivity analysis of various culture systems

	Monoculture	Polyculture	In mangroves	Fattening
Scenarios				
Decrease in price by 20%				
ROI (%)[1]	185	5	47	49
NPV[2]	562650	- 47163	211942	45229
IRR (%)[3]	942	< 0	324	214
Decrease in production by 30%				
ROI (%)	138	- 4	35	13
NPV	389870	- 103682	101797	4644
IRR (%)	696	< 0	171	46

[1]Return on investment
[2]Net present value
[3]Internal rate of return

those from the A-B income classes. A considerable quantity is consumed in restaurants in Manila and other key cities in the country.

Market surveys in selected Asian countries i.e. Bangladesh, India, Sri Lanka, Indonesia, and the Philippines show that demand for mud crab is price-elastic. It increases as the price decreases (BOBP/REP/51 1998 in Agbayani et al. 1997).

The distribution channels of mud crabs are similar to fish marketing. Harvesting of crabs are normally staggered partly because of the limited volume that can be absorbed in the market per trading day as well as the multiple sizes in the pond. The technology of mud crab culture is already being transferred to resource-poor fisherfolk for adoption as an alternative livelihood. Good quality crabs are sold mainly at buying stations to Manila-based wholesalers and exporters. To ensure that crabs reached wholesalers alive, these are air-shipped to Manila. However, freight costs increase. Limited quantities of crabs are sold in local markets, restaurants, and at times to consumers.

Competition among first class restaurants serving seafood and other exotic food is exhibited in terms of gourmet presentation and price. Media advertising and promotions aimed at informing and attracting customers to patronize sea food products are very evident.

Processing

Processing of mud crabs is not extensively practiced in the Philippines because of consumers' preference for live crabs. In general, processing is done mainly for export due to difficulty in shipping live crabs. Freezing crab meat is one method of processing crabs for export. Only cooked crabs and crab products are frozen in whole, halves or block forms (Meade et al. 1973). The recovery of the meat of frozen raw crabs is more difficult and is therefore, not recommended.

Blast freezing in a plate or individually quick frozen (IQF) method is also used. Immersion in chilled brine is another method. The crab meat can be frozen in blocks, glazed and packaged for marketing purposes. Recommended storage temperature is -20^0F or lower.

In big crab processing plants, bacterial sampling of crab meat is done to ensure the safety of the product. The crab is separated into claw, body, and lump meats before freezing in block plates in trays or IQF. Crab meat is then packed in sealed plastic trays and placed in cardboard boxes for shipping in containers.

Another method of crab processing is canning. The whole crab is cooked and the crabs are then backed, declawed, cleaned, and extracted or picked. The crabs are reboiled or blanched to ensure proper cooking and the blanched meat are then placed in lacquered cans.

Pasteurizing is another crab processing method, especially for blue crabs (Meade et el 1973). In this method, the water temperature where the crabs are kept is raised to 188 to 190^0F. This method has no effect on the flavor of the crabs. It brings down bacterial counts from 10,000

to 45,000 g^{-1} to 3,000 g^{-1}. Pasteurization also extends the refrigerated shelf life of blue crabs.

Conclusions

With proper management and adoption of mangrove-friendly technology, mud crab farming in the Philippines and in other Asian countries can be economically viable and environmentally sound. The figures in the economic analysis in this paper support the long term viability of mud crab farming.

Breinl and Miles 1994 predicted that the world market for mud crabs is projected to increase in the coming years. The increase in demand for crabs will attract investors, especially those who were formerly engaged in shrimp culture and are now looking for alternative profitable species. The demand for seeds is expected to surge, leading to high prices. Small growers, especially fisherfolk who are now into mud crab culture in mangrove areas will be adversely affected by the increasing production cost. This will also lead to overexploitation of crabs from the wild for stocking in ponds and other fish farms. There is, therefore, a need to hasten the development of the broodstock and hatchery technology to augment the source of stockable seeds in ponds. SEAFDEC/AQD is undertaking an extensive transfer of crab culture technology to the private sector in coordination with non-government organizations and local government units. Existing shrimp hatcheries that have been left idle because of the slump in demand for shrimp fry can be utilized as mud crab hatcheries. Hatchery production will help stabilize the supply and prices of juveniles and reduce the cost of production in grow-out farms.

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